Metallurgical & Chemical Engineering

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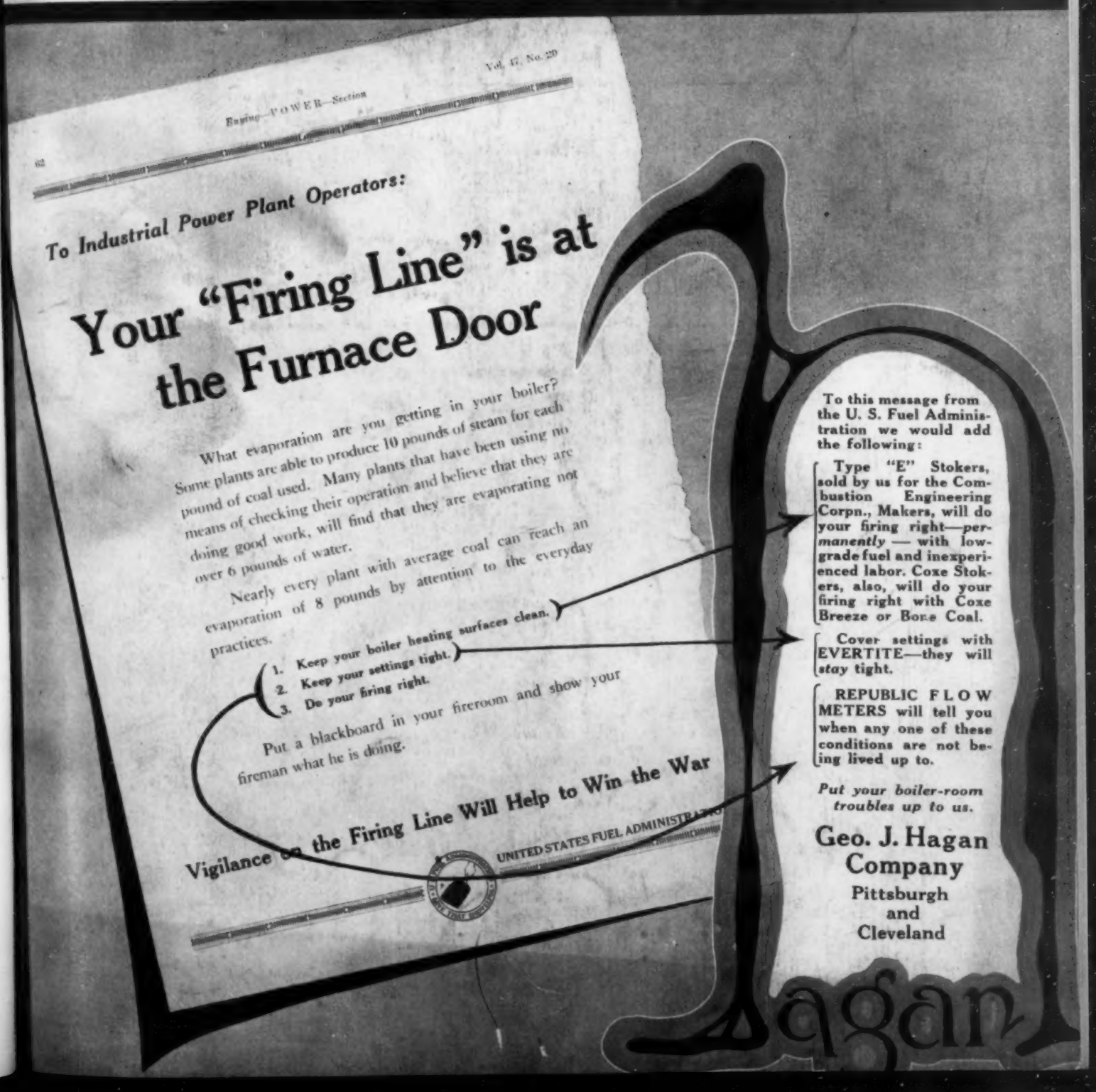
Vol. 47, No. 20
Engng—POWER—Section
62
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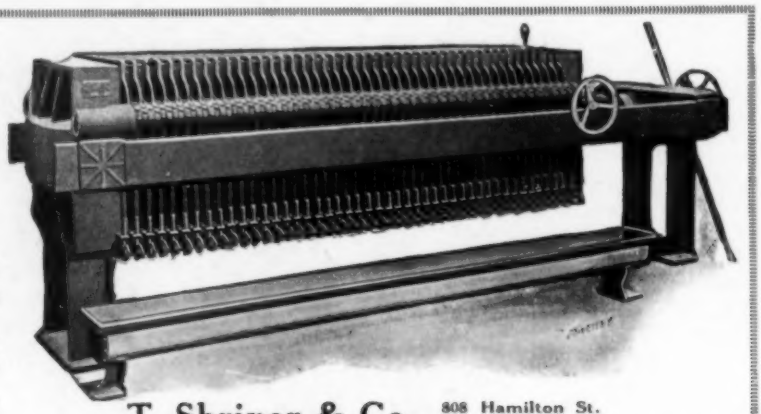

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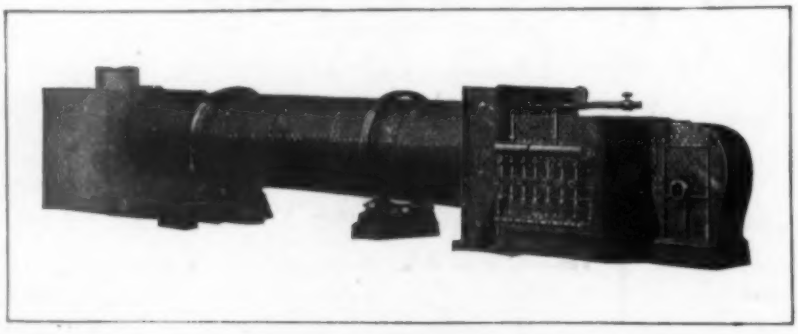

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Beginning to See Light

THERE were a number of gentlemen seated in discussion at the Crystalloid Club. That is not its corporate name, but the disposition of its Committee on Admissions to function as a permeable membrane against applicants for membership suggests the appellation. Among the company was one of the leaders of the New York bar. "There is a man," said he, "who calls at my office occasionally to collect money for a welfare organization, and I usually give him a little contribution, rather to get him to talk than for his cause. He travels all over the country and he is a very observant person. His comments are keen and I get more out of him than he gets out of me. The other day he was in a talking humor and I asked him how the people of the West or South feel about the war. 'You New Yorkers,' he answered, 'do not seem to appreciate how much alike the people of the country are: ours is the only nation in the world which is nowhere provincial. With the exception of certain colonies of foreigners that remain unAmericanized, the people of the United States are the same, not different. Whether I am here or in Buffalo or Chicago or Omaha or San Francisco or Galveston or New Orleans or Atlanta or anywhere else, the cities have a remarkable cousinship in appearance; the men are alike, each after his kind; they dress according to the same fashions and their habits of thought are very similar. Abstract ideas, unless they bear upon local conditions, are received in much the same temper all over the country. I do not mean to say that our cities or centers lack individuality, because Americans are too much alive to travel in herds or be dull, but they are nowhere provincial.

" 'Take the news-stands, for example. Everywhere I find the same periodicals and in about the same proportions: the same little piles of literary magazines and reviews, the same larger piles of the cheaper ones, the higher stacks of the periodicals for women and the still higher ones of the *Saturday Evening Post*, with the usual proportion of Hearst's Lures of Sex for the Adolescent. The whole country reads the same literature, both good and bad, and discusses it. Now that is what holds us together: reading the same literature at the same time. It is what is backing up the country in the resolution to win the war. I take it that your friends are safe and loyal. Well, so are the friends of nearly anybody else, no matter where he lives, in the United States. Of course there are hot-beds of sedition and of German propaganda here and elsewhere, but they are getting about the same treatment in one place as in another. Think how little unity of interest there would be among our people if they thought only of their business; of what they produce! But they have

unity in literature, the literature of every day. These periodicals, which are so widely read, gather in sentiments from all over the country and spread them abroad. They make us laugh together and cry together. Where they are published is unimportant; it is the habit of writing in terms of the whole nation that makes them such great factors. And I really believe that if the zone system of postal rates is established, it will forbid national circulation, and there is serious danger that this will kill the very thing that has taken us so long to build up: the unity of the people. I cannot imagine a more insidious method than this to bring about provincialism and the envy and ill-will that is sure to follow it. It is a destructive attack upon the national community of mind.'

"I declare," continued the leader of the bar, "I believe the man was right." The others agreed with him and proceeded with unanimity to consider ways and means to combat the impending danger.

Furnace Slags in Theory and Practice

ONE sometimes resents the intrusion of the physico-chemical-minded metallurgist with his phase rule rudely unhorsing us from that simple hobby that our furnace slags are quasi-chemical compounds, and can be accurately termed singulo-, sesqui- or bi-silicates. Even before the advent of this scientific irritant, the hypothetical behavior of alumina was always a fly under the saddle blanket, and the pestiferous question as to whether it should be figured on the acidic or the basic side of the equation provoked reams upon reams of discussion. Fortunately the most of our furnaces worked calmly on, smelting high alumina and other unreasonable ores without waiting for the decision to be rendered, which probably will arrive the same day the disputants can find some definition of the terms "acid" and "base" which will apply at temperatures so far above the boiling point of aqueous solutions. At any rate, when furnace computation is sifted down to realities, do we not merely try to approximate some slag which experience has taught will be suitable?

Thus we sidestep the fundamental questions which the equilibrium diagram solves, and which chemical analysis alone is as incapable of solving as it was the age-old mystery of hardened steel. The researches of the scientists at the Geophysical Laboratory have blazed the way for a rational interpretation of the chemistry of silicates, and have proved, for instance, that in the ideal case of lime-silica slags only four chemical compounds exist in all possible compositions, from pure silica to pure lime, namely SiO_2, $CaSiO_3$, Ca_2SiO_4 and CaO. In such a series sub-silicates, sesqui-silicates, and tri-silicates simply have no objective existence. Again, the iron blast-furnace with its additional aluminous burden produces slags in which the stable entities are gehlenite and calcium metasilicate.

However, the laboratory metallurgist should not fail to visit his brothers in the cast-house regularly and often, going with the attitude of a student seeking information rather than that of an instructor dispensing wisdom. Else he will probably work a long time before he discovers that the furnace man consistently avoids the use of the slag composition which has the lowest melting point, primarily because it is so viscous that it cannot be handled. On the other hand, the furnace man believes (and he may very likely be right in his belief) that one of his biggest jobs is to get all the lime, magnesia, alumina and silica charged at the top to come out at the bottom, be it as $CaSiO_3$, Ca_2SiO_4, or what not. He likes to formulate some simple rule easy to work by (and who can blame him), such as "the higher the lime the more sulphur will go to the slag," bolstering it up with a nice reaction between calcium oxide and iron sulphide which balances neatly and looks good. But it isn't elastic enough to stretch over all the facts! In his dilemma, the works metallurgist, if he is friendly to the laboratory metallurgist, can get information to the effect that his rule is wrong simply because calcium oxide as such has not appeared in any furnace slag since the invention of the cinder notch, *except*—and here even the wise physico-chemico-metallurgist will have to venture on another voyage of discovery—except for the possibility that the silicates formed in the topmost part of the smelting zone may dissociate into chemically active entities under the intense heat of the focus.

Really, that is the fun of it! There is always something left to look into, always the unexplained to be explained!

Recognizing the Metallurgical Engineer

AT the last meeting of the Board of Directors of the American Institute of Mining Engineers the sentiment was formally expressed that a change in name of the organization would be desirable in recognition of that element of the membership concerned primarily with metallurgy as distinct from mining.

The proposal is not new, but the action of the Directors of the Institute is the first step toward crystalizing an opinion that has been held and frequently expressed by many. A census of Institute members would show but one-third primarily interested in and devoting their energies to metallurgy. On the other hand a classification of Institute technical literature would disclose a predominance of papers devoted to metallurgy. All this is by way of logical evolution from the time when the duties of the mining man were not only to dig the ore out of the ground, but to operate a stamp-mill or smelting-cupola as well. With the exploitation of low-grade ores and new ones not known or needed in the earlier state of the art, came the demand for expert advice in ore treatment; and with the later developments in the production and uses of ferrous and non-ferrous metals and alloys, a new phase of metallurgy developed which is growing in significance.

At the present time there is a bid for metallurgical allegiance to several organizations. There is the Iron and Steel Institute, which had some excellent technical papers on the program at its recent meeting in New York. The impression prevails, however, that this association is engrossed with the purely business aspects of the industry. To a metallurgist, the American Foundrymen's Association is more like a trade organization, from which the American Institute of Metals branched several years ago; but even the latter deemed it advisable to join the A. I. M. E. in a body, forming the Institute of Metals division. In addition

to these there are the Mining and Metallurgical Society of America, which functions most actively in New York City; the American Electrochemical Society, which comprises an eminent body of engineers skilled in electrometallurgy; the Steel Treating Research Society, comprising an important and growing class of men who supervise the toolmaking and control the quality of the product of progressive metallic-manufacturing establishments; and the American Chemical Society, which has proposed the formation of a metallurgical section on the score that metallurgy is chemistry applied to the treatment of ores and metals. This Society is now the largest in its field, having grown rapidly in the last few years. It has rendered excellent service in mobilizing the American chemists for war, and all members of the profession should rally to its ranks. It may lay claim to the allegiance of metallurgists, but in our judgment the rapidly expanding field of industrial chemistry offers a greater opportunity for predominance by this important organization.

Evidently there is need of concentration of effort and interest. We are fully alive to the difficulties in the way of inducing societies, once organized, to lose their identity by merging into a large central body. There will always be organizations, numerically small but professionally important, devoted to highly specialized phases of the metallurgical industry. Nevertheless, under the present circumstances we incline toward the idea of making an "American Institute of Mining and Metallurgical Engineers" the great representative body of American metallurgists. The action of the Institute of Metals has pointed the way, and we hope the prospect will be bright enough to attract iron and steel metallurgists who may have felt no interest in a society of mining engineers. With the change in name they can feel perfectly at home, can have their special meetings and aid in promoting the solidarity of the profession.

All Steel for War

A YEAR ago, when technically we had been at war for two months, estimates ranging from 15 to 30 per cent were being made as to the proportion of the country's steel output the Government could use for waging war. Now the Government is requiring that all the steel be diverted to war use.

There is a wide difference between the estimates and the realization, and the divergence is emphasized by the fact that the authorities at Washington intimate that if the steel industry could produce still more steel that extra amount would not constitute a "surplus" for general distribution, because Washington would find a use for it also.

Why this great divergence? The arts of war have not changed in a twelvemonth, nor did those who made the 15 to 30 per cent estimates have incorrect appraisals of the amount of steel a single ship or shell or gun would use. It was their viewpoint as to the participation of the United States in the war that was incorrect. The Government had declared the state of war and "the people" were going to "support" the Government in some intangible way—give the Government its countenance and sympathy.

The condition to-day, however, is that every man, woman and child in the United States is, or should be, helping in one way or another to conduct the work of war. With such a condition obtaining it is a relatively simple matter for the war to absorb all the steel. The machinery and labor that ordinarily fits the products of the steel mill for actual useful employment is being utilized or will be utilized to fit the steel for war use and the labor that ordinarily uses these finished products will now use them in waging war.

The railroads, which for decades have been the best single customer of the iron and steel industry, have been made a government agency to aid in the prosecution of war. All steel used by the railroads is war steel. The building industry, normally a large consumer of steel, has been mobilized for war. The structural shops, instead of producing fabricated steel for bridges and buildings, are turning out parts for fabricated ships and fabricated material for innumerable storage warehouses on both sides the Atlantic. The automobile industry will build many tens of thousands of army trucks and many thousands of passenger cars for the army. Agriculture, normally a peace industry, is now a war industry and requires steel just the same. The production of fuel has become a war industry, and it will consume more steel rather than less, in the coal mine and in oil and natural gas development and transport. The production of many minerals is to be stimulated as a war development. The building of ordinary dwelling houses, to meet individual desires of the people, stops of its own accord by reason of high costs of material and scarcity of labor, but when population migrates in order to engage in war work new housing facilities must frequently be provided, and that involves a considerable amount of dwelling house construction, strictly a war necessity.

This glance at what is occurring industrially suggests the viewpoint that the war has not absorbed the steel directly, it has absorbed the machinery, the implements, the men that normally handle, fabricate and consume the steel. If the war were absorbing only one-fourth the steel output as was at one time expected, who is there to use the other three-fourths? The difference between the forecast and the realization is due simply to the much greater measure of control the war has taken of the entire people.

Thus the picture that is sometimes sought to be drawn, particularly in the daily press, of how industries are to be deprived of steel, becomes a very vague and shadowy one. In general, they are not deprived of steel to any greater extent than they are deprived of the opportunity to work with it, if they received it for ordinary uses, and sell the manufactured products that would result. The dislocation, or to use a word with a much better ring, the alteration, is not simply in the distribution of steel, but in all the activities of the people.

It might be impossible to effect an alteration sufficient to consume all the steel, seeing that this amounts to more than 30,000,000 gross tons a year, measured in the form of finished rolled steel, when prior to the war the production less exports was only about 20,000,000 tons; but our Allies have capacity to use much more steel than they can produce, and the shipping situation is such that we can transport a very large tonnage of steel to them.

Readers' Views and Comments

Intensive Toluol Production

To the Editor of Metallurgical & Chemical Engineering

SIR—In view of the great improvements in the recovery and manufacture of toluol carried out in this country since the war began, I was keenly interested to read the views of Mr. Lichtenhaeler in his article on "Intensive Toluol Production" in your issues for Feb. 1 and 15. The experiments and developments recorded are indeed worthy of the traditional thoroughness and skill of American engineers and chemists, but I may be pardoned in taking exception to a few of the principles as set forth in above article.

Under "Developing of Resources," questions of supplies are divided into three main arteries, crude petroleum products coming under item No. 3.

The writer has had considerable experience in the manufacture on a commercial scale of toluol from petroleum products, experiments being carried out with kerosene and fuel oils, and it can be definitely stated that at the present there is no "cracking" method which will give a satisfactory aromatic toluol. In the first place the approximate yield of pure toluol obtainable from crude oil is not more than 2½ per cent by volume, and actual costs including sale of by-products, such as gas, motor-spirit, etc., to produce one gallon of toluol in Great Britain was about $7.50. It is the writer's opinion that no method has yet been invented which is capable of yielding a toluol absolutely free from paraffins or cyclo-paraffins, which bodies tend to widen out the boiling range of pure toluol, and as proved by commercial-scale fractionation 0.5 deg. toluol cannot be produced from such sources, the same remarks applying to toluol from water-gas tar, or vertical-retort tar.

It is quite possible that the toluol produced distilling over a range of say 2 deg. C., can be nitrated and any paraffins or cyclo-paraffins separated by simple distillation. However, the presence of a small percentage of impurity such as the above has a tendency to detrain benzol into the toluol fraction, and this benzol seriously interferes with the resulting nitrated product, the merest trace of nitrated benzol in the nitrated toluol product causing the lowering of the melting point with consequent difficulty in the manufacturing process.

Referring to Fig. 1, it would be interesting to know how this process can be applied to coke oven plants or gas works dealing with say 2 to 5 million cubic feet of gas per day, as the cooling surface, etc., required would be enormous, and the plant as shown would require to be considerably modified in view of the necessary staging required.

With reference to the various efficiencies of the hurdle type of absorber, the "cap and bell" absorber and mechanical absorbers, the writer has had considerable experience in this direction, and can say with all confidence that the following are the relative efficiencies when operating on coke-oven gas and extracting benzol by means of creosote oil:

The hurdle type of scrubber has an efficiency of approximately 80 per cent. The cap and bell absorber, 85 per cent. Centrifugal scrubber of the MacLaurin patent type, 90-95 per cent.

The above figures, of course, refer to the standard sizes supplied for equal capacities of gas per hour, and I am at a loss to understand how the "cap and bell" scrubber, or any other type of scrubber can use a less quantity of oil if maximum recovery efficiency is to be obtained, as in all scrubbing and absorbing processes the efficiency of recovery is entirely dependent on the temperatures of the gas and scrubbing medium and the relative vapor tensions of the compound to be recovered in the absorbing medium and in the gas.

The so-called Carpenter process as employed in Great Britain was an emergency method put into operation at various small gas works which have not the necessary plant and apparatus to recover their benzol and toluol by the creosote oil absorbing process. It must be clearly understood that the calorific scale for the sale of gas is not universal in England, the photometric scale being more predominant, and in most cases the quantity of toluol recovered with tar as an absorbing medium is only 50 to 60 per cent of the actual quantity present in the gas. Most large concerns and coke-oven plants use creosote oil for benzol recovery, and it can be said without fear of contradiction that should the plant be so designed as to allow maximum heat interchange, etc., and careful control exercised, the absorbing oil will last easily two months. Due regard must be given to the back pressure which would undoubtedly be thrown on the exhauster by means of the "cap and bell" absorber as proposed, which from the illustration given, probably will amount to at least 30 in. water gage. Gas managers in the majority of cases would be unable to cope with such enormous resistance, and a scrubber is required, such as the MacLaurin centrifugal scrubber type which does not throw a back pressure on the plant of more than 1 in. water gage, whilst also giving definite relation between absorbing medium and the gas to be treated.

I question the statement whether the hurdle tower requires any more oil as stated than any other scrubber. Creosote oil as a washing medium is undoubtedly the most efficient for the recovery of benzol, and the loss in circulation is extremely small, whilst the price for spent oil approaches that of the fresh oil originally supplied to the plant.

Against the advantages of tar as an absorbent as set forth, we might state that for the same quantity of tar and creosote oil circulated, the former only gives a recovery efficiency of from 50 to 60 per cent, whilst the latter in most cases give 80 per cent, depending on the concentration of the benzol in the wash oil to a large extent, which normally approaches 4½ to 5 per cent.

Most gas and coke oven plants are not fitted with plant to distil their own tar, and should all the toluol and carbolic be recovered as stated, the price of the tar as sent to the distiller will be lowered proportionately. Should a shortage of absorbing oil at any time occur it is possible to substitute same by tar as

produced in the plant, and should this contain an excessive quantity of water, it would be entirely separated in a centrifugal scrubber, having the effect of washing the gas in two stages with water and tar respectively. With a good design of fractionating column and still, very little absorbing oil is carried over with the crude benzol, and in most cases does not amount to more than 5 per cent.

The type of still as shown, having closed steam coil in every section with open coil at the bottom, is now obsolete owing to the enormous wear and tear and erosion on these coils by the cyanogen sulphides and ammonia present in the tar and crude benzol, and which are evolved when subjected to the temperatures of distillation.

The most satisfactory method, and one which has been carried out and improved by the writer's firm, consists in preheating the ingoing oil and then superheating same by steam, passing back vapors and oil into the still separately, the oil being subjected to treatment with a very small amount of open steam, amounting to not more than 2 lb. per gallon of benzol recovered.

It is a moot point whether direct-fired stripping stills hold any advantage over the improved steam-heated type of plant, as the resulting benzol from the former contains a fairly large proportion of entrained higher boiling homologues in view of the absence of any fractionating device. Great risk of fire is also a drawback, and the wear and tear on the still through direct firing and the action of noxious gases is fairly high.

With regard to Article II, it might be stated that we have now had continuous stills in operation for a number of years and designed a complete continuous benzol refinery over twelve months ago (See "Gas World" 1917). With this type of plant it is possible to treat crude products with varying boiling ranges, as these are satisfactorily fractionated to standard products, which can easily be refined with very little still control, being fairly constant in composition. It is a practice in this country to treat say a coke-oven benzol distilling 65 per cent at 120 deg. C., (old retort test) and fractionate same into crude 90's benzol, crude 90's toluol, crude 90's solvent naphtha, crude 90's heavy naphtha, the various products oeing washed separately and fractionated through the continuous refinery and either 90's refined government standard or pure products manufactured in one continuous operation. Such treatment requires efficient columns and dephlegmators for the production of a compound such as pure benzene distilling 90 per cent over 0.5 deg. C. We have designed a new type of horizontal tubular dephlegmator in which the vapors pass through the tubes in a counter-current direction to the cooling water, thus ensuring maximum fractionation and gradual washing effect from the heavier condensed bodies. All returns, etc., are external, and same are easily cleaned in case of chokage by means of naphthalene or other deleterious matter.

With regard to the chemical treatment of crude benzol, this is bound to vary according to the source of the product, and no fixed basis can be taken.

When benzol or toluol is subjected to chemical treatment with sulphuric acid, should any toluol disappear, it is reasonably assumed that same has combined with the acid and formed a sulphonic compound. It is now possible to recover all the unsaturated bodies and aromatics which are lost in this manner. The acid tar is treated in the lead-lined vessel with open steam which decomposes the sulphonic bodies, which are carried over and condensed in special type condenser and subsequently separated and re-washed. The acid recovered amounts to approximately 90 per cent of the quantity used, only, of course, in a dilute condition.

Centralized refining must depend to a large extent on the freights charged for transport of crude benzol, but such a proposal undoubtedly calls for serious consideration after the war.

B. DUNGLINSON.

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Central Stations and the Manufacture of Electrochemical Products

To the Editor of Metallurgical & Chemical Engineering

SIR:—No one who is in touch with the situation can entirely disagree with Mr. Winder as to the conclusions he reaches in his address on "Central Stations and the Manufacture of Electrochemical Products," published in your April 1st issue. His view that the power company which undertakes to furnish steam-generated electric power for an electrochemical industry labors under a serious handicap, is correct in part, for the reason that a 24-hour load accentuates the weakness of its high operating costs and minimizes the strength of its relatively low installation cost. This is especially true today when both installation and operating costs of the steam plant have soared to a much greater degree than has been the case with water-power plants.

Mr. Winder's discussion, however, is marked by one regrettable characteristic which has, as a rule, been common to similar discussions from the point of view both of the electrochemical manufacturer and of the central station industry, the apparent desire to prove a case rather than to learn the truth. As an electrochemist connected with a central station company, the writer feels privileged to criticize this attitude, which has, in the past, characterized both sides of the argument. An impartial statement must be based on all the facts and there are a great many facts to be considered from both points of view. General statements are dangerous because they are seldom based on a sufficiently comprehensive survey of the field as a whole. An analysis of the requirements of each electrochemical industry considered with relation to its possible use of steam-generated power in various parts of the country would be of great value, but such an analysis is difficult to make, and when made does not find its way into print.

The central station man who attempts such an analysis is faced by the fact that a great deal of absolutely essential information is unavailable, because it forms part of the secret stock-in-trade of the electrochemical manufacturer. The electrochemist who attacks the problem from the opposite point of view, although he has this information, will find that he cannot reach the solution without the assistance of someone who has a broad knowledge of central-station rate-making and the details of power supply as practiced by variously situated central station companies. Unless he is very careful

he will fall into the error of reaching general conclusions based on partial information.

Several errors of this nature have crept into Mr. Winder's article. He states broadly that, since central station companies do not produce 25-cycle power and such power is required by most electrochemical industries, this feature "practically precludes the present day central station from entering this field" (with particular reference to ferrosilicon manufacture). On the contrary several large central stations produce 25-cycle power and are prepared to sell it to anyone who prefers it. Mr. Winder implies that any power-factor much below 90 per cent is unacceptable to a central station company and that such a power-factor will increase the cost of power to the customer. As a matter of fact power-factors above 70 per cent are seldom penalized and one large power company, which penalizes any power factor below 60 per cent, gives a corresponding bonus for a power-factor above that value.

The off-peak rate is designed for use by the customer who can use such a rate to advantage, not for the industry which needs to maintain a 100 per cent load-factor 24-hour load. In Chicago the 24-hour load earns a rate very nearly as attractive as an off-peak load of similar proportions and the restricted peak period includes only four hours per day, four months in the year. The 24-hour load is nearly, but not quite, so desirable from the power company's point of view as the off-peak load, and the rate is fixed accordingly. Surely, under such circumstances, it is hardly fair to speak of "a twenty-four hour load undoubtedly penalized from a bookkeeping standpoint in favor of the domestic consumer," or to refer to "the inability of steam stations to make consistent rates for twenty-four-hour power."

When the economic value of power sources is being considered, the importance of their location must by no means be neglected, but when it is stated that the artificial abrasives industry cannot "stand more than a five-hundred-mile haul under the prevailing prices of water power," one begins to wonder. Where do the industries of the Middle West get their abrasives or are they still using the natural product? What portion of the United States can afford to use carborundum made at Shawinigan Falls? On this same 500-mile basis, isn't it possible that steam-generated power could profitably be used to manufacture abrasives to supply a well developed industrial territory situated more than 500 miles from the nearest developed water power available for this purpose?

The writer does not claim to know that steam-generated central-station power can be used economically in any wide degree by the electrochemical industries. To speak frankly, he doesn't know and hasn't so far been able to find out. Favorably located central-station power can be purchased in large blocks for from $50 to $60 per kilowatt-year, if it is to be used at a load-factor of 90 per cent or better for 24 hours per day; but that doesn't answer the question, nor does a learned discussion of freight rates fill the gap in the required information. What are the relative costs of the different factors involved in the various sorts of electrochemical manufacture? As those manufacturers are now conducted, what proportion of the total cost is represented by the bill for electric energy? Those who know won't tell and it doesn't pay to guess.

From some of the discussions of this subject which have been published one might assume that electrochemical industries, as a class, are burdened with power charges which form 50 to 75 per cent of their total cost of manufacture and distribution. But is this assumption a safe one? For example, consider the case of aluminium, which requires some 12.5 kilowatt-hours for every pound of metal made, and which Mr. Winder very properly specifies as "perhaps more dependent upon the low cost of power than any of the other above mentioned products." And yet, it is something better than a wild guess to estimate that the cost of carbon electrodes consumed per pound of aluminium is nearly as great as the cost of electrical energy, at the rates usually paid for energy in that industry.

One would suppose that the proper method to pursue in ferreting out the answers to all these questions—assuming that it is really desired to answer them—is for the electrochemical industries and the central station companies to get together for a full and frank discussion of the variables involved and their relative importance. A beginning along this line was made last year when a joint committee was appointed by the American Electrochemical Society and the National Electric Light Association, for the purpose of considering this very subject. The first report of this committee, however, does not give the impression that very much progress was made. Perhaps it is too much to expect that much progress can be made in a public discussion of economic matters, the true details of which are shrouded in secrecy and jealously guarded. The writer ventures to predict, however, that no general conclusions worthy of consideration will be arrived at, until our arguments pro and con, are based on the facts, all the facts there are, and nothing but the facts.

H. M. St. John.

Commonwealth Edison Co.,
Chicago, Ill.

Long-Range Bombardment of Paris

To the Editor of Metallurgical & Chemical Engineering

Sir:—The first day of the bombardment of Paris by the long-range German gun followed a night of bombing by enemy airplanes. No one at that time realized that shells were being sent into the city from a point behind the front-line trenches which are at least 75 miles from the center of the city. I was out on the streets the morning the bombardment began and everybody was under the impression that it was a *daylight* air raid, something entirely new, as of course all of the previous air raids had been engineered under cover of darkness. The sky above Paris was thick with French fighting planes, scooting here and there in search of enemy machines. It was not until late that day that we realized that the explosions did not come from bombs. The excitement was intense and everyone was mystified, for explosions were occurring at regular intervals of about twenty minutes, and no enemy machines could be spotted overhead.

The regular *alerte*, which is a warning sounded at the approach of German bombing machines, was given early in the morning, and both the "Metro" and the "Nord-Sud" the two Paris subways, were shut down in order that the stations platforms and underground tubes could be used as a refuge by the people of Paris. The

street railways stopped operation. Cars were emptied, motormen and conductors left their platforms, and the rolling stock was left standing in the street wherever it happened to be when the *alerte* was given. Traffic was absolutely paralyzed and the only wheels turning were those of the taxicabs.

As a matter of fact the shutting down of the subways in order to furnish underground retreats for the population defeated the very purpose for which it was done. In an hour or two people got tired of staying under ground and came up for a breath of fresh air. Many of them had to get from one part of the city to the other, and the only way of doing this was by walking along the streets. Therefore, with the subways shut down, there were far more people on the streets and subject to danger from explosions of shells than would have been the case if the lines had continued their normal operation. This fact evidently was appreciated later, for during succeeding bombardments by the long-range gun, the subway system has continued in operation.

The damage done by the long-range gun is much less than that which results from the dropping of bombs by an airplane. I have seen a good many of the buildings hit by the long-range shells and they seem to damage only the two upper stories. The bombs, however, wreck things to a greater depth, sometimes as much as four stories. It often happens that when a shell strikes, the panes of glass on the opposite side of the street are shattered, while those on the same side remain intact.

Detonations of explosives are such a regular event here that the store-keepers are going to great trouble to protect their windows from breakage. The favorite stunt seems to be to paste across the glass long strips of paper. It seems to me that these Parisian shop-keepers have something to learn in the matter of window protection from New York merchants, whose stores were situated along the excavations for the new subway lines. There it will be remembered the favorite trick was to truss the panes with diagonal wires and struts at the center. I have yet to see one of these rigs in service here. The gummed strips of paper, however, apparently have official sanction, for the windows of the Ecole Nationale des Ponts et Chaussees are dolled up in this way.

The city authorities are busy providing shelters or *abris* for the people during air raids. These are generally cellars of buildings not less than four stories in height. On the entrances to buildings containing cellars which have been officially designated as *abris* are big paper placards indicating the capacity of the shelter. Going along any street in Paris now you see on the buildings these placards with the words "150 places," "80 places," etc. Some of the cellar *abris* had window gratings fronting on the streets. At the present time all of these are being blocked up with plaster to intercept shell splinters.

Although the subway is now kept running during daylight bombardment by the big gun, it is closed during an air raid at night. Those people who seek underground shelter on such occasions now take the experience pretty much as a matter of course and during the last raid I saw people filing down stairs into the Etoile station of the "Metro" with camp-stools, chairs, newspapers and magazines, and other aids to comfort during the two or three hours sojourn below street level.

When a night raid starts the fire engines are sent at full speed through the streets with their sirens going full blast, church bells outside of Paris start ringing, and factory whistles add to the discord. New stationary sirens are in course of installation. Pretty soon the anti-aircraft guns start booming on the outskirts of Paris and from my window I can see the flash of the shells as they burst in mid-air. It looks just like the bunch of sparks produced in grinding metal with an emery wheel. In twenty minutes or so after the guns have started the airplanes which have managed to break through the barrage begin to "lay their eggs." It is very easy to distinguish between the detonation of bomb and the burst of the shrapnel from the "Archies." The bomb makes a deep long roar while the shrapnel produces a higher stacatto note.

An American where I am living arrived just in time to get in on one of the air raids. It was his first. The next morning he had a decidedly haggard look and I asked him what was the matter. He looked out of the window and seemed to be surprised that there was anything left of Paris. "They must have dropped about a thousand bombs last night," he said to me. I could not quite figure this out, as this was one of the nights that the bombing machines had failed to cross the barrage. Finally it dawned upon me that he had assumed to be bombs the detonations of the hundreds of shells which had been fired by the French artillery on the outskirts of the city to form the protective barrage. No wonder he was upset, as there must have been a good many hundred shrapnel fired that night. If these had been boche bombs I probably would not be writing this letter now.

Paris is not greatly disturbed by the shelling of "le canon a longue portee" which is generally dubbed by the French newspaper writer as "la grosse Bertha." People go about their business very much as usual. The moving pictures are taking a crack at the big gun in a humorous way. At the last performance I attended there was shown an "animated cartoon" in which "la grosse Bertha" was sending over shells and Charlie Chaplin (whom they call "Charlot" over here) was catching them, standing forth as the defender of Paris. After he had caught three of these the cartoon showed him juggling them, and finally hurling them back in the direction of Berlin.

While many people have departed from Paris as a result of the air raids and bombardment, the bulk of the population is taking the matter calmly. I have yet to see anything in the nature of a panic. At the pension where I live there is an elderly widow of a French general; she must be at least 70. When the bombs begin dropping she always goes through the motions of a mock courtesy in the direction from which comes the sound of the explosion. Only one or two of the crowd here seek refuge in the cellar. On several occasions they have tried to induce the old lady to descend with them, but she stands her ground, and all they can get out of her is, "Je reste ici."

R. K. TOMLIN, JR.

Paris, France.

Mr. Tomlin is special war correspondent in France for *Engineering News-Record* and other McGraw-Hill engineering publications.—EDITOR.

Western Metallurgical and Chemical Field

Certain Influences on Electrochemistry and Metallurgy in California

The California Railway Commission has been conducting a comprehensive investigation into the need of immediate hydro-electric development to meet the special power consumption of war industries and the normal growth of the community. Their first report as to conditions in the southern part of the state shows that in that region an annual increase in hydro-electric plant capacity of 25,000 kw-hr. will be necessary to keep the oil consumption down to the present figure, and consequently recommends that the operating companies take immediate steps for financing these extensions to the extent of perhaps twenty million dollars. With promptitude and proper priority orders, this annual extension can be provided.

It is perhaps trite to remark that much of this shortage as well as the crying needs of nitrogen fixation and other electrochemical products would now be covered had not hydroelectric development been practically stationery throughout the United States for five years, on account of the lack of a comprehensive national water-power policy. The effect on present and future electrochemical and metallurgical industries in California is also obvious. In Secretary Lane's words, "It is quite manifest to me that there has got to be a very large electrical development if we are going to have the largest development along the lines of chemistry, and perhaps the best sphere for a young man for the next twenty-five years will be as an electro-chemical engineer in the United States. The water powers ought to be put into use now, not only with the idea of taking care of plants that will be commercially successful propositions, but with the purpose of experimenting and discovering what can be done." That the possession of developed water power is an asset of national importance in unexpected ways is shown by the effect of turning unsold power into ferro-manganese at Great Falls. This production will react favorably on the national railway and shipping situation, mining activity in the West, and steel production in the East.

Canadian Mineral Production

A preliminary report on the mineral production of Canada has been issued by John McLeish, Chief of the Division of Mineral Resources and Statistics of the Canadian Department of Mines. He notes that the metal production of 1916 showed a very large increase over that of the previous year, but in 1917 the net result in value has been an increase of only one-third of one per cent. The interrelation of the industry is shown by the effect of a diminished coal and coke output on the metallurgical production; the falling off in production of copper and gold is in part attributable to this cause. The accompanying table gives a view of the situation as a whole, both as to value and quantity.

The British Columbia production of copper amounted to 57,717,535 pounds; Ontario produced 42,796,213, derived chiefly from the nickel-copper ores of the Sudbury district, supplemented by a small recovery from the Cobalt silver ores.

Of the gold production, 27.5 per cent was derived from placer mining, 61 per cent in bullion and refined gold, and 11.5 per cent was contained in matte, blister and residues. Ontario produced 58 per cent of the total; British Columbia's production of $2,776,558 registered a decrease of nearly 39 per cent from that of 1916, due not only to the high cost of supplies but also in part to labor troubles and the closing down of the Rossland mines for several months. Yukon Territory produced $3,671,008 in gold, which is a decrease of over 16 per cent.

The lead production is largely from the Trail smelter in British Columbia, and the figure includes 30 million pounds of bullion, of which a large portion was electrolytically refined.

The 1917 production of nickel has, as usual, been derived from the ores of the Sudbury district, supplemented by a small amount of byproduct metal and compounds resulting from the treatment of the silver-cobalt-nickel ores of Cobalt. The Canadian Copper Company and the Mond Nickel Company produced 78,897 tons of nickel-copper matte, containing 83,773,319 pounds of nickel, and 42,392,588 pounds of copper, resulting from the smelting of 1,453,661 tons of ore. The refinery of the International Nickel Company at Port Colborne has not yet been completed, while the smelter and refinery of the British American Nickel Corporation near Murray, Ontario, is progressing slowly. Nickel to the extent of about 700,000 pounds was also recovered as a by-product from Cobalt ores in smelters at Deloro, Thorold and Welland.

Ontario produced 19,254,616 ounces of silver practically exclusively recovered from the ores of Cobalt and the adjoining silver camps. British Columbia produced 2,580,521 ounces.

During the past two years there has been a recovery of refined zinc in Canada at the zinc refinery erected at the Trail smelter, whose establishment has resulted in a largely increased tonnage of ores mined. The total zinc ore shipments from the mines were about 116,660 tons, containing 61,920,149 tons. Of this, British Columbia produced over 30 million pounds.

The pig-iron production by grades was as follows: Bessemer, 961,656 tons; basic, 14,092 tons; foundry and malleable, 181,041 tons; electric furnace pig, 15,000 tons approximately. No new construction of blast furnaces occurred, and the production of blast furnace pig fell off slightly. On the other hand a small production of high grade, low phosphorus pig iron was furnished from electric furnaces melting down shell turnings and other steel scrap, the salvage of which by this method promises much in the future.

The blast furnace plants operated were the Dominion Iron & Steel Company at Sydney, N. S., the Nova Scotia Steel & Coal Company, at North Sydney; the Standard Iron Company at Deseronto, Ont., The Steel Company of Canada, at Hamilton, Ont., The Canadian Furnace Company, at Port Colborne, Ont., and the Algoma Steel Corporation at Sault Ste. Marie, Ont.

Pig iron was made in electric furnaces by: The Canada Cement Company, Ltd., Montreal; Frazer, Brace & Company, Ltd., Shawinigan Falls, Que., British Forgings, Ltd., Toronto, Ont., Electro Foundries, Ltd., Orillia, Ont., and Turnbull Electro Metals, Ltd., St. Catharines, Ont.

MINERAL PRODUCTION IN CANADA

	1916		1917	
	Quantity	Value	Quantity	Value
Antimony ore, tons	885	$94,537	774	$50,476
Antimony refined, lb.	107,185	41,823	.....	.....
Cobalt metallic and contained in oxide, etc., lb.	840,536	924,590	1,089,134	1,742,614
Copper, lb.	117,150,028	31,867,150	108,860,358	29,588,254
Gold, oz.	930,492	19,234,976	747,366	15,449,426
Iron, pig, from Canadian ore, tons	115,691	1,328,605	46,022	768,783
Iron ore, sold for export, tons	140,601	393,689	169,192	590,336
Lead, lb.	41,497,615	3,532,692	32,072,269	3,571,889
Molybdenite, lb.	156,461	156,461	271,530	271,530
Nickel, lb.	82,958,564	29,035,498	84,470,970	33,778,388
Platinum, oz.	15	600	49½	5,000
Silver, oz.	25,459,741	16,717,121	22,150,680	18,034,419
Zinc, lb.	23,364,760	2,991,623	31,227,351	2,779,547
	.....	106,319,365	.....	106,630,752

Manganese Concentrator at Philipsburg, Montana

A new system for the treatment of western manganese ores has been established by the Philipsburg Mining Company at Philipsburg, Montana, in a mill of 350 tons capacity. The mill has been in continuous operation since January 15, 1918, under the direction of Mr. R. S. Beitz, superintendent, and is doing exceptionally good work. The flow-sheet as operated at present is as follows:

The ore occurs in a limestone formation and the manganese is contained chiefly as a nodular variety of pyrolusite and psilomelane. It is brought from the mines a distance of approximately one and one-half miles in six-horse wagons holding between six and eight tons, and is dumped on a platform under which runs a 22-in. conveyor protected by an 8-in. grizzly. This conveyor elevates the material to a second grizzly having 2-in. spaces—the larger rock going to a No. 4 gyratory crusher and thence to the coarse-ore bin. The material under 2 inches is fed by a 22-in. conveyor to trommel No. 1, covered by 1½-in. round punched plates. This trommel revolves at 16 r.p.m. with a heavy spray of water thrown from all directions on the ore, washing the clay and sandy limestone from the coarser pieces.

The oversize from No. 1 trommel passes to a picking belt where two sorters reject the waste and lean ore; this reject returns to a set of 36-in. by 16-in. rolls, while the balance passes on to the coarse concentrate bin. The undersize from No. 1 trommel goes to the No. 1 elevator and is carried thence to No. 2 and No. 3 trommels. These trommels are identical, being covered for the first half by a ¾-in. round punched plate, and the remaining with ¾-in. round punched plate. All the trommels in the mill are heavily sprayed with water.

The undersize from the ¾-in. screen passes to No. 4 trommel, while the undersize from the ¾-in. screen goes to two double two-compartment Hartz bull jigs. The oversize from No. 2 and No. 3 trommels passes to the 36-in. by 16-in. rolls crushing the picking-belt reject, which operates in closed circuit with No. 1 elevator and trommels Nos. 1 and 2.

No. 4 trommel is covered with a four-millimeter round punched plate; the undersize passes to No. 5 trommel, and the undersize goes to one double two-compartment Hartz middling jig.

The No. 5 trommel is covered with one-millimeter diagonal slot screen; the undersize passes to a 10-ft. cone tank for dewatering before feeding to tables, while the oversize passes to two double two-compartment Hartz fine jigs.

The tailings from the jigs are returned to the 36-in. by 16-in. rolls and are reground, eventually appearing as table feed. The cup concentrates from the two bull jigs, together with the cup and hutch product from the middling and fine jigs are dewatered by a Dorr thickener, and then elevated to a steam-pipe dryer above the fine concentrate bin. The hutch product from the bull jigs is treated on one No. 5 Wilfley table; and the tailings from the middling and fine jigs are treated on three No. 6 Wilfleys. The fine sand which comes over the Dorr thickener is settled and again treated on one No. 6 Wilfley. The table concentrates pass to a conveyor and are elevated to a bin; the middlings and tailings go to waste.

A fair average of the assays is:

Heads, Mn 32%, SiO_2 35%; washed ore, coarse, Mn 41%, SiO_2 18%; concentrates, Mn 49%, SiO_2 9%.

Work of the Seattle Station, Bureau of Mines

The Pacific Northwest Experiment Station of the United States Bureau of Mines at Seattle is investigating electrometallurgical and ore dressing matters in cooperation with the College of Mines of the University of Washington, the School of Mines of the University of Idaho, and the Oregon Bureau of Mines and Geology, under the general direction of Thomas Varley, Superintendent.

The electrometallurgical laboratory is in charge of F. C. Ryan, and is equipped to make both electrolytic and thermoelectric investigations. The electrolytic apparatus consists of a 5-hp. motor-generator set capable of giving a current range of from 0 to 100 amperes and a voltage range from 0.25 to 15 volts, together with auxiliary equipment to take care of combined leaching and electrolytic problems.

The electrical equipment of the thermoelectric laboratory consist of two 140-kv.a. single-phase transformers with voltage regulators to give a range from 35 to 480 volts with transformers in single-, two-, or three-phase position, together with the necessary meters and pyrometers.

Field investigations in this department include a review of the present status of electrometallurgical plant development in the Pacific Northwest and southeastern Alaska, studying the general character of the work, equipment, and operating conditions. During the past year laboratory investigations were made on the utilization of metals from waste tin cans, and this problem is now well in hand. Investigations of ferromanganese and ferrochrome and other ferroalloys have also been made, the experiments being made on a small scale with the idea of experimenting on a large scale later.

Will H. Coghill, metallurgist, has carried on a study of the principles of ore flotation, the physical properties of oils being investigated and their modifying effect upon the surface tension of water determined. These surface tension tests are made with a "drop-weight" apparatus, which is essentially a dropping device provided with a brass tip, wherein the weight of the liquid drop that breaks from the tip gives a measure of the surface tension. The "capillary rise" method is unsatisfactory, but the drop-weight method, based on the well-known law of Tate, is so reliable and accurate that it should become better known. These tests have shown that the surface tension effect of oils is much less than the early technical literature would lead one to believe.

Another subject of investigation is on the angle of

contact between the liquid and the solid. This is recognized as one of the measures of "flotability"; many determinations are therefore being made and the theoretical and practical flotability of various solids on tranquil liquid surfaces are being compared. It has been determined mathematically that a solid, if not too large, is flotable when the angle of contact is greater than zero. Actual tests on tranquil surfaces have confirmed this analysis, but its relation to agitated surfaces is yet to be investigated. The so-called hysteresis angle is also receiving attention.

Work on gravitational ore-dressing has been under the direction of the superintendent of the station, Mr. Varley. During the past year a great many tests have been made on the massive copper-nickel pyrrhotite ore from Alaska, the idea being to make a separation of the copper and nickel from the related gangue. To date this work has been satisfactory as far as the copper is concerned, and some progress has also been made in recovering the nickel in a high-grade concentrate.

Following a visit to the Black Hills a number of samples of tin ores of that region were tested to determine what could be done in the way of recovering the cassiterite by concentration. At the present time very encouraging concentration tests are being made on low-grade chrome ores from Washington, Oregon and California. The same may be said of investigations now in progress on many of the quicksilver ores from plants in California which are using concentration as part treatment.

The work at the School of Mines at Moscow, Idaho, in charge of C. A. Wright, has been along the lines of preferential flotation, and consists of tests on the complex lead-zinc-iron ores of the Cœur d'Alenes. This work is made possible by the operators of the district who assisted in financing the work. The laboratory here has been made thoroughly up-to-date, and at the present time is one of the best equipped for ore-dressing in the West.

Company Reports

Consolidated Arizona Smelting Company.—The concentrator treated 106,226 tons of ore (an increase of 32½ per cent over that of 1916) containing $2.19 in gold and silver and 2.976 per cent copper. The recovery amounted to 90.4 per cent of the copper values, and 75 per cent of the gold and silver, with a concentration ratio of 3.14 to 1. The total cost of milling was $1.776 per ton of material treated, being 27 cents greater than in 1916, which increase was caused by the increase in wages and higher prices for nearly all kinds of supplies, but even to a greater extent by the attempt to fine-grind a larger tonnage that the equipment permitted, and the delays and repairs which naturally resulted. Additional ball mills are to be installed shortly to further increase the tonnage and improve the grinding and will also improve the recovery in the flotation machines. The total tonnage of new copper-bearing material smelted was 138,781 tons, an increase of 34 per cent over 1916 and 100 per cent over 1915. The production amounted to 9485 ounces of gold, 251,670 ounces of silver, and 19,751,042 pounds of copper. The average grade of smelter charge continued to show an increase in gold, silver and copper, the latter being now 7.85 per cent. The cost of producing copper has increased from 13.92 cents in 1914 to 14.98 cents in 1917. In conducting the custom smelting it is possible to equalize this advance by increasing the smelting charges. In purchasing custom ores the company endeavors to buy the copper and silver at the prices it expects to receive from their sale on the assumption of normal time in transit. Delays in the transportation of the blister copper to market during 1917 occurred when the market was falling, and the actual loss from this cause was approximately $120,000. Smelting costs, as shown in the accompanying table, are in part directly dependent upon the equipment. The steadily improved equipment has proportionately counteracted the other factors working even more strongly to increase the costs. Wages have increased 50 per cent during the last three years and coke has more than doubled.

Year	% Recov. Copper	Cost Crush. Receiving Samp. Stor. per T.	Cost Roast. & Reverb. Smelt., etc.	Cost of Convert. per lb. Copper Convt.	Cost of Frt. Ref. & Mktg. per lb. Copper Produc.
1913		$0.959	$4.097	$0.0137	$0.0139
1914		1.094	4.687	0.0058	0.0126
1915	83.978	0.543	2.844	0.0046	0.0153
1916	86.46	0.539	3.494	0.0072	0.0173
1917	90.70	0.489	4.200	0.0093	0.0218

The most serious failing of the smelter has been the heavy loss in metallurgical and mechanical dusting. Lack of roasting equipment has been remedied by the construction at a cost of $298,000 of four Wedge furnaces with Cottrell treaters, and an efficient system of belt conveyors. Over $100,000 was spent in remodeling and improving the equipment of the smelter, installing a third converter and a new crane, resulting in an increase in converting capacity of over 25 per cent. At Humbolt much work still remains toward improving living conditions. The company has always been seriously handicapped by inadequate and inferior living accommodations which have made it difficult to secure and retain the services of the best class of employees, and this condition has been emphasized by the recent influx of married men taking the place of the single ones who have been drafted.

North Star Mines Company.—A total of 126,474 tons was mined and delivered to the sorting plant, which eliminated 25,974 tons as waste, leaving 100,500 tons of ore which yielded values of $11.43 per ton, and a tailing containing about 40 cents. Of these values, 82 per cent were recovered by amalgamation and the balance by cyanidation. During the year $61,600 was expended, largely in equipping the Central Mill with sixty 1,500-pound stamps, and the enlargement of the Central Cyanide Plant, to perform the work formerly done by two 40-stamp mills with separate cyanide plants. The costs were as follows:

Milling	$0.611
Cyaniding	.458
Tailing Disposal	.028
Bullion	.034

on the basis of per ton crushed. G. B. AGNEW, president of the company, remarks: "The purchasing power of gold has materially decreased each year of the war, with the result that the business of gold mining, generally has been seriously affected, and should the cost of supplies continue to rise, it is possible to foresee a situation where the Government might find it necessary to take measures to protect or to assist this important industry."

Hollinger Consolidated Gold Mines, Ltd.—This report shows a satisfactory financial progress, since in spite of the general shortage of competent labor a deficit of $269,590.93 existing on Jan. 1, 1917, has been converted into a surplus of $712,724.00 while during the year plant expenditures amounted to $673,237.52 (largely due to increasing the capacity of the mill at Timmins, Ontario, to 2500 tons per day) and $100,000 were written off for plant depreciation. Large additions to the physical equipment are now about completed, and its valuation amounts to $2,333,083.84. The mill worked at reduced capacity, treating all the ore which the mine was able to supply. Labor conditions were decidedly bad, especially during the first part of the year. Many of the miners are alien enemies, and while the average number of men employed was 1045, approximately 2700 men were hired and paid off during the year. Wages range from $4.00 to $8.00 per day. The report contains an unusually detailed distribution of expense, which would repay study, but which cannot be presented owing to lack of space. A comparison of operating results follows:

	1917	1916
Tons milled	514,301	601,584
Percentage of possible time running	70.2	91.1
Tons per 24 hours actual running	2007	1810
Stamp duty per 24 hrs. running	15.4	16.7
Solution precipitated per ton ore	2.15 tons	2.221
Average value per ton milled	$8.60	$8.84
Values in one ton of tailing	$0.31	$0.38
Cyanide consumed per ton ore	0.448 lbs.	
Zinc consumed per ton ore	0.36 lbs.	0.405
Lime consumed per ton ore	2.257 lbs.	2.113
Lead Acetate consumed per ton ore	0.331 lbs.	0.0042
Average value of pregnant solution	$4.038	$3.782

New Cornelia Copper Company.—The new leaching plant at Ajo was completed early in the year, and on May first the work of spreading the ores in the leaching tanks was commenced. The first shipment of electrolytic copper was made on June 18th, and the total since that time has been:

Electrolytic Copper	12,764,848 lb.
Cement Copper	3,316,283 lb.
Copper in shipping ore	3,401,060 lb.
Total	19,482,191 lb.

In addition to this there is 3,456,584 pounds of recoverable copper locked up in the process, including starting sheets, unfinished cathodes, solutions, and cement copper in launders. On the basis of copper shipped, the earnings were 19.5 cents per pound, and the expenses 15.8 cents. The difficulties experienced in starting the plant were not fundamental, and were easily overcome. The most serious was due to a lack of the proper number of launders for the precipitation of cement copper. The amount of iron and alumina dissolved from the leaching ores builds up in the solution, and it is necessary to continuously remove a large percentage of the returning low-copper electrolyte, replacing it with fresh acid and water. While additional precipitation launders were being built, the solutions became supersaturated and the extraction ran down from 80 per cent to as low as 65 per cent. In the future, steps will be taken to decrease largely the amount of copper recovered in the cementation tanks, since the latter costs two cents per pound more to make, and suffers a deduction of 3 per cent for smelting loss as well. The hard lead anodes which were possible sources of trouble in the electrolytic tanks show no serious corrosion after months of use. Two additional towers for the reduction of ferric salts by means of SO_2 gas have been constructed, which towers show an absorption of over 80 per cent. With this new equipment, it is thought possible to make a total production of over four million pounds of copper monthly, instead of the three million originally planned. During the year a favorable contract with the Minerals Separation Co. was signed, and a test plant will shortly be erected to devise the proper grinding equipment and a flow sheet for the sulphide ores. Mining operations in the oxidized zone will probably uncover in three years a sufficient quantity of sulphide ores to justify a flotation plant of 10,000 tons daily capacity.

The McKinley-Darragh-Savage Mines of Cobalt, Ltd.—This report calls attention to the fact that the average price for silver received was larger during the current year than previously, but this increase was more than offset by the added expense of labor and material, and the decreasing silver content of the ore. The general relation of production to costs and receipts for the past few years is clearly shown in the following table:

Year	Ounces recovered	Average Price Received	Total Costs	Net Profit
1912	2,717,383	$0.6166	$0.1859	$0.4307
1913	2,214,036	0.5919	0.2233	0.3686
1914	1,396,540	0.54385	0.31325	0.2306
1915	1,107,815	0.50785	0.2871	0.22075
1916	925,779	0.67364	0.4073	0.26634
1917	908,756	0.832	0.5709	0.2611

The total tons of ore treated in the mill amounted to 68,142, or an average of 197.56 tons per day. The average mill heads were 13.434 ounces silver per ton, tails, 1.795 ounces, giving an extraction of 87 per cent. During the year a mill was built to re-treat the accumulated tailings, which was fully equipped with the exception of the necessary grinding machinery. The mills were promised for delivery June 15, 1917, but had not yet arrived on Feb. 1, 1918.

Calumet and Arizona Mining Company.—In the reduction works at Douglas, Arizona, two blast furnaces operated a total of 689 furnace-days and smelted a total of 585,975 tons of ore. With an average of 13.3 furnaces operating in the roasting department, 451,255 wet tons of ore were reduced from 31.6 per cent sulphur to 10.2 per cent. The decreasing ratio between oxidized to sulphide ores tends to the reduction of the grade of matte, and greatly embarasses the converter department. A crushing department to operate on roaster charge is therefore in contemplation, which will enable the production of calcine containing about 6 per cent sulphur. Four reverberatory furnaces operated a total of 1419.2 furnace-days and smelted 420,458 tons of calcines, 62,871 tons of fettling, 27,173 tons of flue dust and 14,505 tons of flux. Additional waste heat boilers are to be installed, which will largely augment the excess power generated over that required to run the smelter, and which is now being transmitted to the mines in Bisbee, up to an eventual total of about 1700 kilowatts. The 200-ton acid plant started operation in March, and has operated successfully since the start. Five roasters deliver gases averaging 5.67 per cent SO_2 at a temperature of 840 deg. F. The total production has been 50,225 tons of 50 deg. Baumé acid, while the daily average since October first has been 223 tons.

Notable Meeting of the American Iron and Steel Institute

A NOTE of optimism dominated the fourteenth general meeting of the American Iron and Steel Institute in New York on May 31. At the annual banquet 1100 guests listened intently as Judge GARY, CHARLES M. SCHWAB and J. L. REPLOGLE told of the part the iron and steel industry is playing in the war. The audience was repeatedly roused to a high pitch of enthusiasm as the speakers expressed in patriotic terms the determination to win the war and obtain peace through victory.

JUDGE GARY'S ADDRESS

By way of emphasizing the fact that we must constantly look forward and not be concerned with the mistakes of the past, Judge GARY said:

"It would be useless to discuss what ought to have been done to prevent certain conditions. We are not at this time particularly concerned with the past. It would not be useful now to refer to the awful things that are being done in Europe, except for the purpose of emphasizing in the strongest words and in the best possible manner the fact that we personally are not without courage, we are not without vision, we are not without appreciation of our responsibilities.

"The steel industry is doing much to assist in carrying on this war. The American Iron & Steel Institute has been carrying on a very large work. It is in close communication with the Government officials all the time. It is a source of securing information and of distributing it to the Government officials. It is the agency upon which the Government depends very largely for its assistance in carrying on many of the activities essential to the war.

STEEL INDUSTRY IN GOVERNMENT FAVOR

"We find to-day Government officials in high places coming to the steel men with the statement that they want to co-operate with us, that they want our assistance; that they depend upon our loyalty and our ability to assist the Government in this time of great distress.

"It is to my mind a source of gratification that we may look forward to the future with hope and expectation that the Government of the United States is going to assist, to foster prosperity and business enterprise, instead of attacking it.

"We are doing another thing, gentlemen, and the Government is permitting us, assisting us, urging us to do it. We are day by day putting our affairs in better shape; we may not be making so much money, or if we do make it we may be paying it out in taxes and in extensions to our works for the benefit of the Government at such cost that we are absorbing our profits, but, nevertheless, we are putting our works in better condition; we are being better prepared for the future, the iron and steel industry will be on a better basis and a better footing than ever before; well prepared to succeed in the contest and the competition for international trade. If we win the war, that will be worth something to us, if we do not save much in cash. If we lose the war then it is not so important whether we have anything or not."

REPLOGLE PLEADS FOR EXTRA TONNAGE

J. L. REPLOGLE, director of steel supply, devoted his remarks mainly to the increasing war demand for iron and steel, and emphasized the necessity of producing an extra tonnage in those lines of steel products necessary to win the war. "War necessities is a rather flexible term," he said, "and it has been given much thought and consideration by those in authority at Washington."

"I had a conference Wednesday with the representative of the corset industry. It developed that their profits last year from this great industry aggregated $40,000,000, and that they require 15,000 to 20,000 tons of high carbon spring steel annually. I am no authority on corsets, but I must confess that after a complete discussion of the subject I was not prepared to dispute their claim that corsets were absolutely an essential.

"There have been many lists of so-called non-essential industries prepared at Washington, but they have never been officially issued, as there has never been complete agreement on this subject. All industries are essential from one standpoint or another—if no other, from the standpoint of the owner, and we have preferred to reverse the procedure and prepare a list of the more essential industries, giving them such preference in steel supply, fuel, transportation and labor as are necessary to get the results for which we are all striving.

"It may be surprising to many of you to learn that we now have unfilled orders on the books of the steel manufacturers and on our desks at Washington for 16,800,000 tons of steel for the United States and Allied Governments and the orders are coming in at a greater rate than they are being executed, although I believe we are near the peak of production. Difficulties of some of our gallant Allies are very great. Coal in Italy is $140 per ton, and its steel industries are working under great disadvantages. A very large per cent, probably 75 to 80, of the steel and coal in France is now either in the hands of our enemy or within the range of his guns. The requirements of our Allies will be enormous and the least we should do is all that we can do to give them steel when and as needed.

"The railroads of our country need more rails for safety and efficiency of operation, and it is difficult to give them any increase without restricting the production of projectile steel, which is largely rolled on rail mills. The forging plants are now getting under way, and have just reached the point where their consumption of projectile steel will be an extremely heavy factor. The shipyards have their ways built and many keels laid, and under the direction of Mr. Schwab will require vast tonnages of steel. His program for next year is at least double that of this year, and we must furnish him the steel to complete the great work he has to do and for which he is so well qualified."

SCHWAB SAYS ENCOURAGEMENT, NOT CRITICISM, NEEDED NOW

The hearty approval of the appointment of Mr. SCHWAB as director general of shipbuilding was voiced by the applause which greeted him as he rose to speak. He prefaced his remarks by saying that he was burdened with the great responsibility and with the

thought that the unmeasured confidence of his friends must not be disappointed.

"We all seek the encouragement and approbation of our fellowmen and I rejoice that because the great steel industry has given its approval of my selection, there has come greater enthusiasm and patriotism to men throughout the country which will mean much in winning this war; but, after all, no individual can be a very great factor. The undertaking is so vast that we must have the hearty support of every man, woman and child in the country. Some of us have been prone to criticise, but I should not be fair if I did not say that the work of Hurley, Piez, Goethals and others has been magnificent. When this country entered the war, all the shipyards were engaged in building ships for the navy and the yards for other ships had to be created. I have examined 65 to 70 per cent of the shipbuilding capacity of the country and I wish to say that the accomplishment is wonderful. What is needed now is not criticism, but encouragement.

"During May the United States finished and placed in commission 250,000 deadweight tons of ships. Every workday two such ships as that launched yesterday by the Submarine Boat Corporation were finished, and May will be the month of least production. I do not intend to indulge in prophecy, for that is dangerous, but I will say that you will not be disappointed. It is necessary that every industry connected directly or indirectly with shipbuilding shall be enlisted in the great work. So stupendous is the number of ships that the contracts for new works now aggregate $250,000,000. On the Great Lakes from 400,000 to 500,000 tons will be built this year, but that is not enough and capacity will be increased so that next year 1,000,000 deadweight tons will be produced. I am not worried about the steel, for I believe that it will be produced. The industry has more loyally come to the support of the Government than has the great steel industry. The shipbuilding capacity will be increased wherever necessary."

Technical Papers Presented

At the technical session the following papers were read:

The Electric Steel Plant at South Chicago, by T. W. Robinson. The Design of the Modern Blast Furnace Stack, by J. G. West, Jr. The Modern By-Product Coke Oven and Its By-Products, by W. H. Blauvelt. Effects of Phosphorus in Soft Acid and Basic Open Hearth Steels, by J. S. Unger. Conservation of Ferro-Manganese, by C. R. Ellicott. Relation of the Trade Papers to the Iron and Steel Industry, by Bertram S. Stevenson.

Manganese Price Scale

Schedule for Domestic Product Premiums and Penalties

THE War Industries Board has approved the scale of prices agreed to by the American Iron and Steel Institute. The following schedule gives domestic metallurgical manganese ore prices per unit of metallic manganese per ton of 2240 lb. for manganese ore produced and shipped from all points in the United States west of South Chicago, Ill. This schedule does not include chemical ores as used for dry batteries, etc. The prices are on the basis of delivery f.o.b. cars South Chicago, and are on the basis of all-rail shipments. When shipped to other destination than Chicago, the freight rate per gross ton from shipping point to South Chicago, Ill., is to be deducted to give the price f.o.b. shipping point.

For manganese ore produced in the United States and shipped from points in the United States east of South Chicago, 15c. per unit of metallic manganese per ton shall be added to above unit prices.

Above prices are based on ore containing: Not more than 8 per cent silica and not more than 0.25 per cent phosphorus, and are subject to:

Silica Premiums and Penalties: For each 1 per cent of silica under 8 per cent down to and including 5 per cent, premium at rate of 50c. per ton. Below 5 per cent silica, premium at rate of $1 per ton for each 1 per cent.

For each 1 per cent in excess of: 8 per cent and up to and including 15 per cent silica there shall be a penalty of 50c. per ton; for each 1 per cent in excess of 15 per cent and up to and including 20 per cent silica there shall be a penalty of 75c. per ton.

For ore containing in excess of 20 per cent silica, a limited tonnage can be used; but for each 1 per cent of silica in excess of 20 per cent., and up to and including 25 per cent. silica, there shall be a penalty of $1 per ton.

Ore containing over 25 per cent silica subject to acceptance or refusal at buyer's option, but if accepted shall be paid for at the above schedule with the penalty of $1 per ton for each extra unit of silica.

All premiums and penalties figured to fractions.

Phosphorus Penalty: For each 0.01 per cent in excess of 0.25 per cent phosphorus there shall be a penalty

PRICES PER UNIT OF METALLIC MANGANESE FOR ORE CONTAINING WHEN DRIED AT 212 DEG. FAHR.

	Per Unit
35 to 35.99 per cent, inclusive	$0.86
36 to 36.99 per cent, inclusive	.90
37 to 37.99 per cent, inclusive	.94
38 to 38.99 per cent, inclusive	.98
39 to 39.99 per cent, inclusive	1.00
40 to 40.99 per cent, inclusive	1.02
41 to 41.99 per cent, inclusive	1.04
42 to 42.99 per cent, inclusive	1.06
43 to 43.99 per cent, inclusive	1.08
44 to 44.99 per cent, inclusive	1.10
45 to 45.99 per cent, inclusive	1.12
46 to 46.99 per cent, inclusive	1.14
47 to 47.99 per cent, inclusive	1.16
48 to 48.99 per cent, inclusive	1.18
49 to 49.99 per cent, inclusive	1.20
50 to 50.99 per cent, inclusive	1.22
51 to 51.99 per cent, inclusive	1.24
52 to 52.99 per cent, inclusive	1.26
53 to 53.99 per cent, inclusive	1.28
54 and over	1.30

against unit price paid for manganese of ½c. per unit figured to fractions.

In view of existing conditions, and for the purpose of stimulating production of domestic manganese ores, there will be no penalty for phosphorus so long as the ore shipped can be used to advantage by the buyer. The buyer reserves the right to penalize excess phosphorus as above by giving 60 days' notice to the shipper.

The above prices to be net to the producer; any expenses such as salary or commission to buyer's agent to be paid by the buyer.

Settlements to be based on analysis of ore sample dried at 212 deg. Fahr. The percentage of moisture in ore sample as taken to be deducted from the weight.

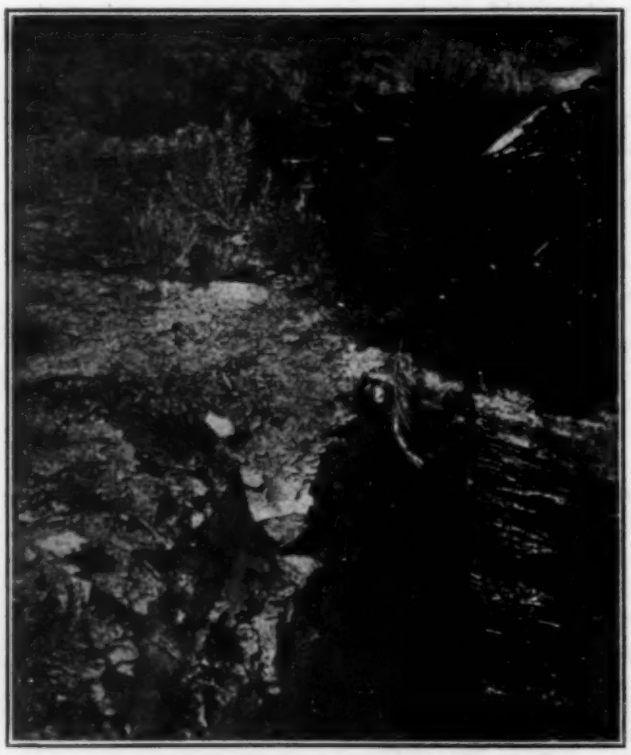
Rubber Substitutes

Factors and Limitations to Be Considered in Studying Rubber Substitutes—Extensive Use of Reclaimed Rubber and Mineral Rubber Decrease Demand for Oil Substitutes in This Country—Glue Substitutes Still Experimental

By ANDREW H. KING

STRICTLY speaking there is not, nor ever will be, a true rubber substitute. A substitute is something which may be used in place of another substance. It is therefore implied that a true rubber substitute would possess physical properties equivalent to rubber. The chemical properties are in most instances merely side issues. It is the valuable physical characteristics of rubber that are desired. These properties are not well known by the people in general, and even many men who work with rubber can not tell you why it is valuable. As a consequence, this field has been the playground for amateur inventors for over fifty years. Thousands of patents have been taken out and much valuable time, energy, and material spent in developing compositions, only to find them without any particular value. Each inventor applied the term "rubberlike" to his product, and thought he had made his fortune. Almost as many separate attempts are recorded in this field as in the pursuit of perpetual motion.

The reasons for this great amount of effort are simple to arrive at. First, rubber is valuable and a true substitute would undoubtedly bring the inventor a considerable sum of money. Second, very few if any of the investigators in this field had the least conception of the properties of rubber. Third, it is extremely easy to make preparations which to the uninitiated resemble rubber. As a result dabbling in rubber substitutes was formerly sort of an apprenticeship course for the amateur inventor.



A DEPOSIT OF GILSONITE

The Valuable Properties of Rubber

But what properties do make rubber a valuable material? Perhaps the most important is the extreme ease with which so many varied effects can be secured. Its adaptability is unrivaled. For example, one can obtain by suitable compounding from the same variety of rubber, stocks which will test as follows:

1. Tensile strength 3500 to 4000 lb. per sq.in. Stretch 2 in. to 14 in. (600%). A tire-tread stock, very tough, resilient, not very hard.
2. Tensile strength 300 lb. per sq.in. Stretch 2 in. to 20 in. (900%). A tire-tube stock, very stretchy; strong; will not tear readily.
3. Tensile strength 2000 lb. per sp.in. Stretch 2 in. to 22 in. (1000%). An extremely soft and stretchy stock. Suitable for frictions.
4. Tensile strength 2200 lb. per sq.in. Stretch 2 in. to 10 in. (400%). Very stiff, hard stock; resists wear; suitable for solid tires.
5. Tensile strength 6000 lb. per sq.in. Stretch zero. A hard rubber.

The stretch may be varied from zero to 1000 per cent; the tensile strength from 1000 to 6000 lb. per sq.in.; the hardness may be anything from that of hard rubber to that of a soft, stretchy tube-stock. Many stocks, as for example the tread of a tire, are exceedingly tough and show great resistance to cutting and tearing. Tube-stocks are much more stretchy, but they also resist tearing to a marked extent. The addition of substitute to rubber decreases the tensile strength without greatly altering the stretch. The effect is dilution, and the more substitute present the weaker the stock.

Capacity for Absorbing Fillers

Another important property of rubber is its ability to take up and hold in solid solution large amounts of various inorganic and organic fillers. Crude rubber when properly manipulated will take up one-third of its own volume of fillers and still produce a product having desirable physical properties. Such a stock may have a tensile strength of 2800 lb. per sq.in., and a stretch of 500 per cent. The addition of a larger volume of filler is not desirable since from this point on tensile strength, etc., rapidly fall off. It is possible, however, to add to rubber up to one-half its volume of filler, but the product is of very little value. By volume of filler I mean true volume, weight divided by specific gravity, and not apparent volume. No substitute so far developed can even approach this record.

Under the head of substitutes I will take up not only the common oil substitutes known to the compounder as "subs," but various other related filling materials whether of an oily or asphaltic nature. These substances, while not true substitutes, do have certain valuable properties when used in the right way. Their general effect is to soften stocks which would otherwise be hard and stiff. Being of low gravity they tend to lower volume costs. Very often they are themselves sticky or tend to make the compound tacky. Consequently they find limited application in friction stocks. Certain of the asphalts and parafin tend to decrease porosity and permeability, and thus increase insulation.

The substitutes which have been proposed from time to time may be classed as follows:

1. Oil products, known to the compounder as subs
2. Asphaltic materials
3. Resinous substances
4. Greases
5. Waxes
6. Glue

Sub

Under this head may be placed those oil derivatives which are listed in market reports as "Rubber Substitutes." The methods of manufacture are as follows:

a. By addition of sulphur chloride to either the raw or blown oil.
b. By boiling the raw or blown oil with sulphur.
c. By heating and blowing with air, or adding nitric acid to the partly blown oil.

The oil substitutes come on the market in two principal classes, namely: white and brown (black). The first is prepared solely by means of sulphur chloride (method *a*), the second by methods *b* or *c*. The vegetable oil employed depends primarily on the market prices, the aim being to use the cheapest obtainable. These oils, as is well known, consist chiefly of glycerides of unsaturated fatty acids. Among vegetable oils the degree of saturation varies. The oil may be nondrying such as cottonseed, semi-drying such as rape or colza, or a drying oil like linseed. From any of these a good sub can be prepared by one or the other of the above mentioned methods. How wide the degree of saturation may vary is indicated in the following table of iodine values (Hehner).

Oil	Iodine Value
Linseed	170—200
Tung	150—170
Castor	82— 90
Rape, Colza	92—109
Corn Oil	111—124
Poppy Seed	133—143
Cotton Seed	104—116
Olive	79— 90

Each maker of substitutes has his own procedure, and the value of his product depends primarily on how carefully he has attended to the details. White substitutes are chiefly chlorosulphides of fatty oils; brown (black) subs are either sulphides of fatty oils, oxides of triglycerides, or mixtures of the two.

1. Vegetable Oils

The following oils are the principal ones which find application:

Linseed, expressed from flax seeds.
Tung (China wood oil) obtained from the nuts of the tung tree.
Castor, secured from the castor bean.
Rape and colza are two oils from slightly different sources but have almost identical constants. They are obtained from plants grown extensively in Europe.
Corn is from the germ of Indian corn.
Poppy seed, expressed from the fruit of the poppy.
Cottonseed, expressed from cotton seeds.
Olive, expressed from olives.

(a) Addition of Sulphur Chloride

There is but little definite knowledge of what actually takes place when oils are treated with sulphur chloride, S_2Cl_2. The action is probably similar to the old vulcanization of rubber which produces an addition product $(C_{10}H_{16}S_2Cl_2)_x$. On adding sulphur chloride to a fatty oil a homogeneous mixture is obtained, which is followed rapidly by an energetic reaction accompanied by evolution of heat. Vapors of sulphur chloride, a little sulphur dioxide, and some hydrochloric acid are evolved. After a few minutes the mixture sets to a solid, yellowish white, rather elastic mass, which may be easily crushed in a mortar. On exposure to air any excess of sulphur chloride evaporates and a neutral substance is obtained. C. O. Weber[1] gives the following proportions of oil and sulphur chloride which he found satisfactory:

100	parts	linseed oil	with	30	parts	S_2Cl_2
"	"	poppy seed	"	35	"	"
"	"	colza, rape	"	25	"	"
"	"	cotton seed	"	45	"	"
"	"	olive	"	25	"	"
"	"	castor	"	20	"	"

There is evidently no relation between the drying power of an oil and the proportion of sulphur chloride it requires to form a solid substance. It has been found in practice that the high temperature resulting from the action of sulphur chloride on the oil is not desirable since it frequently causes carbonization. Consequently it is generally diluted with some solvent, such as light gasoline or carbon tetrachloride. It is also customary to cool the mixture, thus retarding the reaction. If the heat is removed as fast as produced one obtains a perfectly white substitute. The temperature range should not exceed 80 to 100 deg. C. An old recipe for dry white floating substitute is as follows:

15 kg. castor oil, 10 kg. rape, 5½ kg. sulphur chloride in 1 kg. of light petroleum benzine.

The product is ground, spread in trays, and placed on racks to age. On alternate shelves are placed other trays of hydrated lime, which absorbs any sulphur chloride or hydrochloric acid that may be given off. Towards the end of the ageing period a small amount, never more than 5 per cent of magnesie is sometimes dusted over the sub to neutralize any remaining acid. The material is then ready to be sacked for shipment.

The above proportions of oil and sulphur chloride give an absolutely dry substitute. If a more greasy, or tacky one is desired, the quantity of sulphur chloride is lowered and the castor oil omitted. The recipe is now:

25 kg. rape, 4.3 kg. S_2Cl_2, 1 kg. light benzine.

The amount of sulphur chloride can be considerably reduced by using a blown oil. Thus blown cottonseed oil

[1] *J. Soc. Chem. Ind.* 1894, p. 47.

requires only 20 per cent of its weight of sulphur chloride, while the raw oil requires 45 per cent.

(b) Heating with Sulphur

This method or some modification of it is most in use. The process consists essentially of heating an oil or mixture of oils to a rather high temperature, adding sulphur, and maintaining the heat for a certain length of time. The procedure is varied by the different manufacturers, but the following is a representative sample: 100 kg. of raw rape oil is heated in a boiler with 18 kg. sulphur to 160°-200° C. with constant stirring. The oil is first brought to the required temperature and the sulphur added. This may be in any form, provided it is free from acid, since all varieties melt at this temperature. The reaction is exothermic and once started the fire can be withdrawn. The end point is indicated by considerable foaming and rising in the kettle. The contents are then poured into pans to cool and congeal. At 145 to 155 deg. C. under pressure this sub flows like a viscous fluid. A much smaller amount of sulphur is necessary if the oil has been previously thickened by heating and blowing with air.

(c) Blowing With Air

The oil is heated in large open kettles to 160 deg. C. or above and air is blown through for some time. The speed with which it thickens up depends to a great extent on whether it is a drying or a non-drying oil. Thus linseed oil thickens up quickly but cottonseed requires a much longer time. China wood oil congeals in a very few minutes when merely heated to 250 deg. C. With the average oil mixtures the heating and blowing is continued until a small sample when cooled sets to a mass having the desired degree of toughness, elasticity, etc. In fact, this is the general procedure followed in all substitute experiments.

Sometimes the oxidation is catalysed by the addition of a small quantity of lead or manganese oxides. Lime or magnesia may also be used. The employment of lead or manganese oxides is not to be countenanced, because these substances bring about oxidation of the rubber, thus producing a poor ageing stock.

Addition of Nitric Acid to a Blown Oil

A very fine, light substitute is made in this manner. An example is as follows:

Nitric acid which has been diluted with twice its volume of water is added to a partly oxidized oil and the mixture boiled and blown until the reaction has gone as far as desired. On cooling the product is ground and washed well with water to remove all the acid. Just the right amount of acid must be added or the preparation will be spoiled.

With sulphur chloride one can obtain a nice, dry substitute, or a tacky one as desired. By suitable combination of blowing and addition of sulphur any degree of hardness, from a soft, sticky mess to an extremely hard, black resinous mass, can be produced. It matters little what oil the substitute is made from provided it is well prepared. It is frequently adulterated with paraffin, vaseline, or even mineral oil. A small quantity of paraffin is harmless, but mineral oils are certainly not. Free vegetable oil is much less destructive but is not particularly desirable. The free sulphur content must be known and allowed for in compounding the material. In order to cheapen their product some makers will add even as high as 20 per cent (by weight) of inert material such as barytes or aluminium flake. This is not often met with, however, since sub is always supposed to be of low gravity and is recommended for floating stocks. In general the ash should be very low. This merely insures the compounder that his sub is pure and he is getting value for his money. For obvious reasons the sub should contain no mineral acids and should not contain any ingredients which are liable to bring about spontaneous oxidation. In the end there is only one real test: that is actual trial. A new variety of sub should not be put into use until thorough age tests have been performed.

As previously stated, these substances are not in any sense real substitutes, and their true nature, which is that of fatty oils, is not altered by the vulcanization through which they have passed. They are still triglycerides, and therefore saponifiable. To this fact their limited use is due. They will not withstand high temperatures, steam, etc., and always decrease the strength of the rubber with which they are mixed. The sulphur content in white subs does not usually exceed 7 per cent. In the brown or black varieties it may vary from 3 to 20 per cent. Subs are insoluble in alcohol and acetone, and also insoluble in the usual rubber solvents but swell in them. Treatment with alcoholic potash always saponifies and dissolves them. About ten years ago every rubber laboratory kept a large bottle of this solution in stock solely for the examination of new substitutes.

Analytical: The first work on this subject was done by R. Henriques.[2] His results are often quoted and are still of value. They are given in Table I.

TABLE I.

	Commercial Products					Linseed Oil Sub from		Colza Oil Sub from		Poppyseed Oil Sub from	Castor Oil Sub		Sub from Oxidised Cotton-Seed Oil
	White Substitute			Brown (Black) Sub							With Min. Amt.	With Max. Amt.	
Determinations	A_1	B_1	C_2	A	B	Fresh Oil	Blown Oil	Fresh Oil	Blown Oil	Blown Oil	S_2Cl_2	S_2Cl_2	
Sulphur in the substitute	6.4	6.17	8.25	15.48	17.71	9.34	4.78	8.28	6.59	7.68	4.82	10.6	6.23
Chlorine in the substitute	5.0	5.86	8.88	0.7	0.36	8.84	4.85	7.62	5.95	7.44	6.70	8.95	5.36
Water in the substitute	0.85	1.00	.....	.....	.....	3.02	0.85	....	....	....	....	....	....
Residue on ignition	0.8	5.51	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Fatty acids	90.45	73.58	.....	.....	.....	79.6	81.67	87.95	74.9	85.35	.....	.....	.....
Sulphur in the fatty acids	6.12	6.45	8.15	14.14	15.2	9.88	4.06	8.34	6.54	8.32	5.32	.....	6.44
Chlorine in the fatty acids	0.83	0.43	.....	.....	.....	Trace	0.60	Trace	Trace	....	0.26	Trace	Trace
Iodine absorption of substitute	30.9	31.0	32.6	42.0	42.0	56.3	52.6	32.5	26.9	33.6	35.2	21.9	30.3
Iodine absorption of fatty acids	91.3	91.2	102.3	129.0	125.6	160.3	141.2 121.0	101.5	102.8	133.3	136.2 147.4 152.1	143.5	91.5
Acetyl number	.....	.....	.....	.....	.....	21.0	19.6	31.0	....	....	.....	105.6	51.3

A_1 and B_1, from oxidized oil. C_2 from raw oil.

[2] *Chem. Zeit.* 1893, 17, 634-638.

The determinations usually made are:

1. Acetone extract, which removes
   (a) Unvulcanized oil
   (b) Unsaponifiable matter, which includes
      (1) Paraffin which is crystallized in the usual manner
      (2) Mineral oil which is indicated by a flourescent extract
   (c) Free sulphur.
   White sub contains from 1 to 2 per cent free sulphur. Over 3 per cent shows defective manufacture or reversion during storage.
2. Chlorine
3. Total sulphur
4. Acidity
   Dubosc states that there is always free acid, which is rarely in excess of 2 per cent. This is due to oleic acid. Dissolve in neutral alcohol and titrate. For mineral acid, which should be absent, extract with hot water and titrate.
5. Ash
   For brown sub 1 per cent is about the limit. In white subs a little lime or magnesia will usually be found. The latter should be in excess, since in the presence of a little oil it gives a non-deliquescent oxychloride. The presence of hygroscopic substances causes sub to decompose in storage.

TABLE II. WHITE SUB

Make	English Per Cent	German Per Cent	French Per Cent
Non-vulcanized oil	10.3	7.7	13.8
Free sulphur	0.8	0.3	2.1
Vulcanized oil (by difference)	86.2	89.4	81.3
Combined sulphur in extracted sub	6.7	7.2	6.4
Chlorine	7.8	7.7	7.2
Ash	1.0	2.6	2.8

TABLE III. BROWN SUB WITHOUT HYDROCARBONS

Make	English Per Cent Hard	English Per Cent Hard	German Per Cent Medium	German Per Cent Soft	French Per Cent Medium
Variety					
Non-vulcanized oil	21.7	9.6	22.7	17.2	23.6
Free sulphur	0.3	0.1	0.2	0.1	1.5
Vulcanized oil (by difference)	77.1	90.2	77.0	82.5	74.3
Combined sulphur	13.1	16.3	7.1	10.2	9.8
Ash	0.9	0.1	0.1	0.1	0.6

TABLE IV. BROWN SUB CONTAINING HYDROCARBON

Make	English Per Cent	German Per Cent	German Per Cent	French Per Cent
Variety	.....	....	Fine Para	Fine Para
Non-vulcanized oil	25.1	10.6	25.0	23.4
Free sulphur	2.5	1.6	0.5	0.4
Paraffin	20.1	....	21.3	25.2
Mineral oil	.....	23.1	.....	.....
Vulcanized oil	51.3	64.6	52.5	47.9
Combined sulphur	13.8	13.5	3.6	3.1
Ash	0.1	0.1	0.7	0.1

Tables II, III, and IV contain analyses of foreign substitutes published by Dubosc in *Le Caoutchouc et la Gutta Percha.* Table V contains analyses of some American substitutes, made by the writer some time ago.

TABLE V.

	A Per Cent	B Per Cent	C Per Cent	D Per Cent	E Per Cent
Acetone extract	5.50	23.02	10.5	49.4	25.5
Total sulphur	7.3	.....	....	24.10	19.10
Free acid	None	0.005	....	None	None
Free sulphur	0.05	.....	....	11.13	3.50
Solution in hot alcoholic potash	Complete	.....	....	.....	.....
Ash	7.85	15.20	3.0	0.70	0.12
$BaSO_4$	5.51	13.05	....	.....	.....
MgO	2.19	1.10	....	.....	.....
$CaCl_2$	0.27	0.98	....	.....	.....

A, B, and C are white subs; D is black sub from corn oil; E is brown sub from rape oil.

Satisfactory samples of white sub will not show more than 15 per cent acetone extract and not over 5 per cent ash. Black and brown subs should not give over 25 per cent acetone extract nor ash higher than 3 per cent. Mineral acid should be absent in all cases.

In Europe substitutes are used much more extensively than in this country. American manufacturers, particularly tire companies, have not taken kindly to them. They hold that employment of sub is not only risky but productive of rather poor results. Another factor in this country is the huge supply of first-rate reclaimed rubbers many of which are of low sp. gr. No sensible manufacturer needs to use sub merely because he must cheapen this or that compound. He will use shoddy and produce, for the money, a higher quality stock than he could with sub. In Europe they formerly were not as successful with reclaiming practice and had to resort to substitutes, which they developed to a high degree.

2.—Asphaltic Materials

Under this head we will consider the following:

a. Coal Tar
b. Coal Tar Pitches
c. Asphalt Pitches
d. Mineral Rubber

Coal Tar

Coal tar, as such, finds a limited application, chiefly in reclaiming and in the compounding of exceedingly dry and hard shoddies. The amount used will never be more than 5 per cent but is usually 2 or 3 per cent based on the finished stock. It softens a stock and makes it more easily worked, for example, in a tube machine. The medium grade of tar which serves very well is about as thick as corn syrup, remains fluid as low as 10 deg. C. and should lose not more than 5 per cent when heated for 1 hr. at 100 deg. C. As indicated, it is only employed in very poor stocks for mechanical goods, as for example, stair pads, cheap heels, novelties, and cheap frictions.

Coal Tar and Asphalt Pitches

These two varieties of pitches, while coming from different sources, are very similar in their physical properties and use. Coal tar pitch is obtained by the distillation of coal tar and is marketed in many different grades which vary both in hardness and in melting point. Depending on the severity of the treatment it may vary from 37.5 deg. C. to 174 deg. C., and the constitution from a thick tar to a very hard, resinous mass. A piece of it may be easily chewed without any crumbling. Asphalt pitch may be either purified natural asphalt or the still residue from the distillation of asphalt base oils.

Both asphalt and coal tar pitches contain some mineral oil, and consequently their use beyond certain limits is dangerous because of the disintegrating action. The melting point varies from 100 to 130 deg. C. When added to rubber on the mills they soften and are easily dissolved. They make a batch soft, easily worked, and somewhat sticky. As a consequence they are much used in mechanicals for softening stocks which are to be run on a tubing machine, for frictions, and in cheap molded goods in which they function to a certain extent as binders. The quantity added will vary with conditions, but as a rule must not be greater than 15 per cent, otherwise there will be serious difficulty in milling the

stock which will stick to the rolls and be extremely hard to cut off. Eight to 10 per cent is the usual figure.

These pitches are soluble in benzole, carbon bisulfide, chloroform, carbon tetrachloride, about 50 per cent soluble in acetone, and about 70 per cent in naptha. The sulphur content may vary from 0 to 5 per cent, but is usually around 2 per cent or lower. Free carbon is much more important. It is liable to vary from 5 to 25 per cent but should be absent.

(d) Mineral Rubber

It is perhaps stretching a point to class coal tar and the pitches as rubber substitutes. Yet there is a good economic reason for it. If by means of certain pitches and the cheapest possible reclaim one can make a satisfactory stair tread, then there is certainly no reason for using fine para and high priced compounding materials. The policy is to suit the product to the purpose. But mineral rubber commonly known as MR is different. Coal tar and the pitches find their widest application in cheap mechanicals. MR can be used in all the high grade stocks except those which must be very white in color. It is by far the best substitute ever brought out. Stocks which must withstand the more severe conditions are actually benefited by the substitution of a small percentage of rubber by MR. That its merits are appreciated by the rubber trade is shown by its rise in price. In 1913 a good grade could be obtained for 1c per lb. By 1915 it was 2c and now it costs about 5c. When one considers that it is made from practically a waste material the rise in price is clearly due to the demand.

Mineral rubber, MR, is a hard, black, resin-like substance which readily passes into solid solution when added to rubber on the mixing rolls. The melting point by the cube method varies from 160-185 deg. C. When added on the mill, the heat of the rolls and the rubber (20 to 70 deg. C.) combined with the mastication it receives, softens it to the point where it is readily taken up and homogeneously distributed throughout the mass. When handled on a factory scale it is impossible to add more than 35 lb. of MR to a 100-lb. batch. The rubber absorbs it but becomes so soft and tacky that it cannot be cut off the mill. In regular practice 20 per cent is about the limit. More than this makes milling so difficult that the stock is likely to be overworked. In high grade stocks not more than 10 per cent should be used because of certain properties which will be discussed later. MR is essentially a bitumen. The first preparations were made by carefully combining gilsonite or grahamite with purified natural asphalt to give the desired physical properties. The next step in the development was to blend gilsonite or related bitumens with coal tar or asphaltic pitches. Following this, certain enterprising manufacturers discovered that they could produce an apparently good MR by cooking and blowing for a long time still residues of asphalt pitch. Today, much MR is made in this way and only two or three firms actually use any gilsonite. The processes in vogue are largely secret, but enough of the general procedure is known to realize that the operation is extremely simple. The important points are the selection of materials and the proportions in which they are combined, which must be learned by experiment. In order that the problems which confront both the maker and user of MR the nature and origin of bitumens will now be briefly discussed.

Asphalt: According to Engler the asphalts are derived from petroleum hydrocarbons through polymerization, free oxygen acting as a catalyser of the change. It has been shown that the formation of asphalt takes place more readily in the presence of air, yet the amount of oxygen absorbed is too small to account for the formation as oxidation.

The principal source of natural asphalt is Trinidad lake, which contains apparently an unlimited supply. According to Richardson[3] crude Trinidad asphalt contains 28 to 30 per cent water. In the dry state it has 56 per cent bitumen and 38 per cent mineral components. The remaining 6 per cent is water of hydration of the clay and some insoluble organic matter. The pure bitumen softens at 76 deg. C., melts at 83 deg. C., sp. gr. 1.032 at 25 deg. C., and contains 82.33 per cent carbon, 10.69 per cent hydrogen, 6.16 per cent sulphur, and .81 per cent nitrogen. It contains 63 per cent naphtha soluble malthenes of great viscosity and gummy consistency. The remainder is chiefly very hard and brittle asphaltenes. The Trinidad asphalt is mined with pickaxes, and somewhat purified by melting. Unless this is done very carefully by steam a part of the asphalt will be destroyed by overheating thus producing free carbon, which is contained by the poorer grades in amounts up to 11 per cent.

When this asphalt is to be used for paving no attempt is made to separate the high mineral content which is really valuable for this purpose. The molten asphalt is poured through a wide-mesh screen (1 cm.) to remove sticks and large stones. To completely purify it for use with rubber is rather expensive. Settling operations will do much, but the best way is by use of solvents, thinning the solution, settling, decanting, and filtering. The pure solution is then concentrated by evaporation and the solvent removed.

Residuum asphalts (artificial asphalts) are made from the still residues when asphalt base oils, such as those from Mexico, Texas, or California are distilled. With Pennsylvania, straight chain, oils paraffin is the end product, but with these oils, cyclic, asphalt is obtained. The asphaltic residue is then further treated by long cooking, during which air is passed through the melt. Artificial asphalt is really an accelerated natural asphalt. The nature of the product is dependent on

1. The duration of the cooking period. 2. The temperature. 3. Amount of air passed.

The product may be very soft or very hard, depending on the conditions.

Properties of Asphalts: They (both natural and artificial) are almost entirely soluble in carbon bisulphide and carbon tetrachloride; about 70 per cent soluble in 86 deg. B. naphtha; about 75 per cent soluble in ethyl ether; fixed carbon 0 to 15 per cent; melting points lay between 55 and 100 deg. C; loss on heating 5 hr. at 163 deg. varied from zero to 5 per cent. Sp. gr. at 15 deg. C. about 1.04; sulphur from .5 to 4 per cent. The asphalts consist to a very considerable extent of hydrocarbons not acted upon by sulphuric acid, that is, saturated hydrocarbons. Gilsonite on the other hand contains but a very small amount of such components.

[3]Petrol 7,1347

Data concerning this has been published by Richardson, as shown in table VI.

TABLE VI.

	Sp. Gr.	Per Cent Solution in Naphtha	Per Cent Saturated Hydrocarbons
Petroleum flux (Texas)	0.958	97.5	72.8
Residual pitch	1.089	65.0	33.1
Bermuda asphalt	1.082	62.2	24.4
Gilsonite (Utah)	1.044	47.7	5.5
Grahamite (Okla.)	1.171	0.4	0.3

Gilsonite and Grahamite: Grahamite is the result of metamorphic changes in gilsonite, which was in turn produced by metamorphic action on petroleum. The two materials present varying degrees of condensation, from the softest gilsonite which will flow in the sun to the hardest and most brittle grahamite which will not melt even at high temperatures.

The changes as metamorphism proceeds are indicated by the gradual decrease of the hydrocarbons and their derivatives which are soluble in naptha, from the amount present in the softest gilsonite to that in the hardest grahamite with a corresponding increase in the coke yielded by ignition. In Table VII we have data set forth by Richardson in illustration of this point:

TABLE VII.

Source	Flow of	Sp. Gr.	Per Cent Solution in Naphtha	Per Cent Residual Coke
Residual:				
Texas residual petroleum	...	0.9524	88.0	6.5
Gilsonites:				
1. Utah softest	285	1.011	55.5	10.0
2. Utah	...	1.037	46.9	12.3
3. Utah	260	....	47.2	12.8
4. Utah	345	1.037	46.1	13.9
5. Utah hardest	Intumesces	1.057	24.5	16.7
Grahamites:				
Cuba, Bahia	Intumesces	1.157	38.8	40.0
Trinidad	Intumesces	1.156	14.8	40.0
West Virginia	Intumesces	1.130	9.4	36.8
Colorado	Intumesces	1.160	0.8	47.4
Oklahoma	Intumesces	1.184	0.4	51.4

Depending on the environment, petroleum was converted by metamorphic action into either gilsonite or natural asphalt. Grahamite, as previously mentioned, is derived from gilsonite, which is found chiefly in Mexico, Utah, California, Colorada, and at certan places in the Appalachian mountains. Grahamite is more abundant than gilsonite and is found in the same regions, in the southwest, etc.

Plasticity and Elasticity

Rubber has two important properties, plasticity and elasticity. Before vulcanization it is highly plastic with but little elasticity. After vulcanization it is highly elastic and very slightly plastic. MR is essentially a plastic substance and its introduction increases the plasticity of the resulting stock. This is not a desirable feature since it leads to a high set which may be explained as follows: If a thin piece of tube stock be cut and marked say with marks 2 in. apart and the piece stretched until the marks are 18 in. apart, then released; the distance between the marks will now be found to be greater than 2 in. This excess is known as set and depends on the plasticity of the rubber. The same thing is illustrated by the behavior of a pair of cheap overshoes. They fit well the first few times they are worn, but later develop a set. We say that they have stretched and no longer grip the shoes but slop up and down. This is entirely due to the plasticity of the stock of which the overshoes are made. Plasticity is the principal difficulty with MR. It is a valuable compounding ingredient. It decreases porosity and renders a stock easily worked. It may be substituted for a small per cent of the rubber content but its use is limited by the plasticity it develops in the stock. For high grade compounds not more than 10 per cent is desirable. In certain cheaper stocks such as mechanicals it may be added up to as much as 20 per cent. Used in small quantities it has little effect on the tensile strength and stretch, but as it is increased the set also increases. With larger amounts the physical properties are lowered. The effect when used in excess is to make a tough, snappy stock soft and dead feeling. To prevent confusion it should be mentioned that only a small percentage of rubber may be substituted by MR, never more than 4 per cent in a batch high in rubber, but it may be added to such a stock in much higher percentages in which case it functions as a light gravity filler.

The inspection of MR is extremely difficult. About the only test which is of value is melting point which is best made by the standard cube method. Much depends on the integrity of the manufacturer, and his ability to duplicate his first shipment, which should be given a thorough trial in several stocks and its ageing properties investigated.

As mentioned before, gilsonite is highly unsaturated, consequently MR's containing it are able to unite with sulphur when vulcanized. As a consequence only about one-half the MR added to the stock can be removed by acetone and chloroform extractions. The remainder is insoluble in the solvents ordinarily used in rubber analysis and consequently render a correct determination of the rubber content impossible. For this reason certain specification and analysis committees refuse to admit its use. The policy is rather a left handed one since MR really has certain desirable effects.

Vulcanization with sulphur seems to alter the nature of MR. A sample of MR rubber which contained gilsonite was examined by the writer not long ago. It was entirely soluble in chloroform and about 30 per cent soluble in acetone. A batch was made up containing 20 per cent. On extracting the cured stock 55 per cent of the MR was soluble in acetone, 5 per cent in chloroform, and the rest (40 per cent) insoluble in any solvent which would not attack rubber.

Resinous Substances

In this class are rosin oil, rosin, pitches, and crude turpentine. Their general effect is to soften and render tacky the stocks in which they are mixed. Rosin oil does not age well and should be used with great caution. Representative of the rosin pitches is Oregon balsam, which consists of rosin in turpentine. It is very sticky, and is sometimes used in quantities up to ½ per cent in high grade compounds which are to make good union with other stocks. It is also used in quantities as high as 5 per cent with cheap shoddies, where it acts to a certain extent as a binder. Crude turpentine which is true crude turpentine with the volatile oil removed is used for the same purpose, but is not as efficacious.

Greases and Waxes

Palm oil has long been used as a dope for softening stocks which do not flow smoothly on a calender. Vaseline is employed for somewhat the same purpose but is added directly to the batches during milling. The chief

waxes are Japan and paraffin. The former is really a grease and behaves as one. Paraffin is used quite a little in insulation. It is restricted in other work by the fact that when present over 2 per cent it comes to the surface and produces a dirty white scum.

Glue

There is hardly a rubber chemist who at some time or other has not played with this substance and the interesting combinations which can be prepared by mixing it with glycerine. Glue, glycerine, and vinegar are still used at times for multicopy pads and printer's rollers. But such articles are not strong and are hygroscopic. Many chemists have attempted to make something out of the insoluble product which results when glue is treated with potassium dichromate and alum or with formaldehyde. Many such ideas are patented but none have had any great success. Not long ago an English patent was granted for the manufacture of cheap tubing. The glue glycerine gel was to be fed through a die as in ordinary tube machine practice; the tube dropping directly into a solution of formaldehyde. There is no question that such a tube could be made, but it would have very little strength. Glue glycerine preparations do not work well with rubber. The behavior is similar to an attempt to mix water and oil.

Summary

In the foregoing the writer has pointed out certain factors and limitations which must be considered in studying the rubber substitute situation. Briefly they may be summarized as follows:

1. There is no real substitute for rubber.
2. Oil substitutes are not in great demand in this country because of the extensive use of reclaimed rubber and MR.
3. Certain pitches, greases, and waxes have been mentioned and their principal use stated.
4. Glue substitutes are yet in the experimental stage.

American Chemists' Defensive Measures Against Gas Attacks in France

The Gas Service a Special Arm of the American Expeditionary Forces—Enemy Now Sends Over Gas in Shells, Bombs, Clouds and Hand Grenades—Trenches and Dugouts Must Be Cleared After Attack

By ROBERT K. TOMLIN, Jr.
Special editorial representative in France for the McGraw-Hill engineering publications.

After one has been in France for some time and has had an opportunity of observing the varied character of the operations conducted under the general direction of the Chief Engineer of the American Expeditionary Forces, he begins to realize to what extent warfare on the vast scale of the present day is making insistent and continuous demands upon technical specialists. In previous articles in the McGraw-Hill engineering publications I have referred to a few of the almost infinite varieties of specialized work which our engineers are handling—road-building, railway yards, water terminals, quarrying of rock, light railway construction and operation, water supply at the front, map-making and the itnerpretation of aerial photographs. To these must be added the activities of our engineers and chemists in the gas service.

The men attached to this branch of the Chief Engineer's department are busy both in the field and in the laboratory. Their efforts, as explained to me at our General Headquarters recently by Col. F——, chief of the Gas Service, A.E.F. are being conducted along two major lines—offense and defense. On the matter of our offensive work it is considered advisable to say nothing at the present time. However, certain generalties regarding the German gas attacks and our defensive measures may be permitted, for most of what follows is pretty much of an old story here, although some of it may not be so well known on the other side of the Atlantic.

Few Cloud Gas Attacks Now

There has been for some time past, according to the Chief of the Gas Service, a very general trend away from the cloud gas attack on the part of the Germans. Practically all of the gas now comes over in the form of shells, fired either by long-range artillery pieces, or by trench mortars. There are a number of reasons to account for this change from the original form of attack. In the first place, the prevailing winds on the front have been against our enemy about 75 per cent. of the time. In the second, a comparatively light gas must be used in a cloud attack—a mixture generally of chlorine and phosgene—which is less effective than the heavier "mustard" gas used in shells. Then, too, the wind must be just right before a cloud attack can be launched, and the preparations for the attack in this form are necessarily elaborate, time-consuming, and hazardous, due to the danger of having gas containers punctured by rifle bullets or shells while in transit toward the front-line trenches. The effects of a light gas put over in a cloud are much less permanent than those of the heavy mustard gas.

In the days of the cloud attack, cylinders containing the liquefied gas were spaced along the front-line trenches at intervals so that there was available about 25 or 30 lb. of liquefied gas per foot of front. From these tanks pipe-lines of rubber composition or lead were extended over the parapet and forward a short distance. When the valves were opened it was generally the enemy's practice to begin a violent machine-gun fire to mask the hissing sound of the escaping gas. It is said that the Germans, in the early days of gas attack, started to build some distance behind their front a big manufac-

facturing plant and holder from which gas was to be piped underground to various points of use on the front lines. Allied aviators and artillery, however, by effective bombing and shelling, put a quietus on the central gas plant project.

Wind Velocities

Gas clouds have been launched by the Germans with a wind velocity as low as 2 miles per hour. Four miles per hour is considered fairly safe for the attacking party, but the most effective work can be done with the wind blowing at from 5 to 8 miles per hour. Gas attacks have been made on fronts varying from 1 to 5 miles. Even as far back as 12 miles from the front their effects have been great enough to demand the wearing of masks. The lightest gases used in clouds did not can do damage 10 or 12 miles back of its initial point of discharge.

Being heavier than air the gas will follow the slope of the ground and, if atmospheric conditions are favorable, will sweep down a valley like the flow of a river. The effects of gas are generally confined to points not higher than 30 feet above the general level of the ground. A gas cloud passing down a valley may, therefore, be largely avoided if there are any high points, such as knolls, which can be climbed. Rain or mist has no appreciable influence on the effectiveness of a gas cloud attack.

Gas Shells

When the use of gas in shells was first tried the enemy used just enough explosive to vaporize the charge

AMERICAN SOLDIERS WEARING NEW GAS MASKS IN FRANCE
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produce an effect which lasted more than about 20 minutes; that is, with a 4-mile wind and a mixture of phosgene and chlorine, the all-clear signal could be given half an hour after the cloud had passed over a specific point in the open near the Front, but in dugouts there was danger during a period of 3 hours or more, unless a fire could be built inside to ventilate them, in which case the air became safe to breathe in 15 or 20 minutes. The cloud attack was sometimes launched in one continuous operation and at other times in waves, with a half hour or even greater interval between sucessive clouds. In answer to a question regarding the lateral spread of a gas cloud, the Chief of the Gas Service explained that with a low wind velocity and a high concentration of light gas, the edges of the advancing cloud would become too dilute to do much damage before the cloud attained twice its original width. If launched on a wide front, however, a gas cloud of high concentration of liquefied gas. Several different kinds of gas were employed in the early days of gas shelling before the use of "mustard gas" became prevalent. The noise of the detonation of these lightly charged shells was much less than that of a high explosive shell and it was easy to differentiate between the two. Sometimes, in fact, the low explosive gas shells were mistaken for "duds" (shells which fail to explode properly). Now, however, the amount of the explosive charge in gas shells is being increased, so that almost every bursting shell must be regarded with suspicion so far as gas is concerned.

"Mustard gas" which has been used by the enemy so extensively in shells for months past, is an organic compound containing chlorine and sulphur, known as dichlorethylsulphide. It is employed in shells of all calibers up to 8-in. It produces severe burns if it comes in contact with the body and is painful to the

eyes. Food eaten after having been subjected to the influence of mustard gas has been known to burn the lining of the stomach. It is a very heavy gas and has a fairly high boiling point, 400 deg. Fahr., a fact that makes it unsuitable for cloud attack, for it must be vaporized by an explosion. Gas has killed men as far back at 12 miles from the front. Mustard gas will linger a long time in the vicinity of shrubbery and woods and, forming pockets in shell craters, contaminates the earth, which often must be treated with chloride of lime if there is any chance of men coming in contact with it. With a favoring wind a mustard gas shell can be shot over troops and dropped only 500 yd. ahead of them without placing them in danger.

Gas Specialists Instruct Troops

One of the functions of the Gas Service of the American Forces, so far as defensive work is concerned, is to equip our troops with the means of combating gas attacks and to instruct them in safety measures. With this object in view men specially trained in gas work are assigned to the various units in the field and act as instructors in all matters relating to defense against this form of attack. For the guidance of officers the Gas Service has given much valuable advice on the detection of gas and what to do in case of attack.

Nowadays gas-shell bombardment is to be expected everywhere within the range of artillery—in front line trenches, communication trenches, camps, billets, etc. The enemy's object, of course, is to catch bodies of men unprotected against gas and to develop a high concentration by heavy bombardment. The practice now is either to mix up the gas and the high-explosive shells, or to use gas shells containing a fairly large charge of explosive. This makes it very difficult to detect the beginning of a gas bombardment, especially as the mustard gas has a very slight odor and does not produce an immediate effect on the eyes and lungs. After several hours, however, it causes the eyelids to swell, results in intense pain and loss of sight for from one to four weeks, and, if inhaled, its attack on the lungs soon produces death.

Two Forms of Mask

The instructors from the Gas Service train our line officers in the proper use of the gas-mask and box-respirator, and this instruction is passed on by the latter to the men in the ranks. The so-called mask is the one used by the French armies and is a face-covering with a pocket containing chemicals through which the breath is drawn and expelled. With the mask one breathes through the nose. The box-respirator, the standard for the English armies, is a more elaborate affair, comprising a face-covering, nose-clip, chemical box with check valves and a flexible tube extending from the chemical box into the mouth, the teeth closing on a rubber strip something like that of a foot-ball nose-guard. Breathing must be done through the mouth, as the nostrils are closed by the spring-clip. The box-respirator is considered the more reliable of the two forms of equipment. It proved to be well adapted to our white troops, but when our negro regiments attempted to use it they found the standard clip entirely unsuited for their broad, flat noses. A detail of the Gas Service, therefore, was assigned the job of designing a special nose-clip for negroes.

In the American Forces a box-respirator or a mask must be carried within 12 miles of the front; the choice is optional. But regulations prescribe that the box-respirator must be worn within the 5-mile zone and that

U. S. MARINES IN TRAINING IN FRANCE WEARING FRENCH MASKS
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U. S. MARINES IN FRANCE TRAINING WITH FRENCH MASKS, ENTERING A GAS LADEN CHAMBER
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a man must be clean-shaven, for a heavy growth of beard prevents close contact between the skin and the face-piece, thus allowing gas to leak in. Within the 2-mile zone, the mask and box-respirator must be worn, the latter in the "alert" position—flap open.

Protection of Dugouts

Since all gas used in attack is heavier than air it collects in low spots, such as dugouts and cellars, unless these are protected. Our gas specialists have outlined the best methods of such protection. In the case of a dugout the entrance is to be covered with blankets nailed across the top of the doorway and attached along the bottom edge to a 1-in. x 3-in. plank upon which the blanket may be rolled up. Sometimes these blanket stops are single and sometimes in pairs, the latter forming a sort of entrance lock to the dugout. When the gas warning is sounded these blankets are unrolled and sprayed with water or a mixture of glycerine and water to ensure air tightness.

After a gas attack trenches and dugouts must be cleared. For the trenches a canvas anti-gas "fan," which has the general form of a small snow-shovel, has been devised. It has a short wooden handle and the canvas blade is braced with cane strips; the end and sides of the shovel blade are in the form of hinged strips, the latter making contact with the sides of a trench. With this fan, gas which has collected in a trench is literally shoveled out. The fan is first brought down with a slapping motion and then flicked upward over the right shoulder of the man who is operating it, gas being thrown up over the parapet.

In clearing dugouts ventilation resulting from the building of a fire within them is considered the best method. In general 1 lb. of dry wood per 100 cu.ft. of air space is sufficient. The fire should be kept burning at least 15 minutes. There are also special mechanical fans with filter bottoms for clearing dugouts.

Among other duties connected with the defense against gas are wind observations, at regular intervals, and the collection of samples of gas during an attack. The field work, however, represents only part of the operations of the Gas Service. A staff of chemists is engaged in the laboratory work necessary for the investigation of the countless problems involved.

Paris, France.

France Needs Agricultural Chemicals

According to Vice Consul A. D. Beeler of Bordeaux the proper care of the vineyards requires the application many times during the season of certain solutions of chemicals which have been employed widely for a number of years. These chemicals include copper sulphate crystals, sulphate of iron, sulphur of both triturate and sublimate forms free from sulphuric acid and various special fertilizers for the soils. Some cultivators apply first the sulphate of iron in March as a preliminary measure against the diseases of the vine and in order to clean the stalks. The next application is usually a wash of sulphur, which remains on the vines until after the leafing period, late in April, when the spraying with solutions of sulphate of copper is begun. With the growth of the foliage come new dangers in the nature of diseases, mildew, brack rot, scale, and caterpillars, all of which increase the necessity for the continued spraying of this solution of copper sulphate throughout the growing season until a very short time before the harvests or vintages in late September or early October. Local manufacturers are unable to supply the demand owing to their activities in making munitions, while importation from England is inadequate to supply the deficiency and sulphur importations from Italy are largely curtailed. Copper sulphate crystals are therefore selling in the local markets at from 18 to 21 cents per pound, and the available sulphur supply at from 11 to 13 cents per pound, prices never before known in that region. Under these conditions, it is thought that a large quantity of American chemicals could be profitably exported. The present tariff per 100 lb. is 26c. for $CuSO_4$; 11c. for $FeSO_4$; 26c. for sulphur.

Italian Chemical Manufacturing.—Many chemical manufacturing concerns have been started in Italy since the war. The most noteworthy of these installations are the Solvay soda works at Castiglioncello, and Piedimulera, the explosive plants centering around Cengio, and the ammonia and nitric acid plants at Legnano. In many places the distillation of tar and the production of benzol is under way, while various Italian factories have begun making sulphur dyes and pharmaceuticals.—*Commerce Reports.*

Analysis of Natural Gases*

THE analysis of natural gas by the methods given for the other fuel gases described herein is not very satisfactory. If but little, say 10 cc., of the methane and ethane are exploded with oxygen, any error in read- is multiplied many times. Again on combustion of a large quantity with oxygen, the resultant gas is nearly pure carbon dioxide and, its solubility in water varying with its percentage, consequently a relatively large quantity is dissolved. The second contraction, i.e., on absorption of carbon dioxide, being low, the result is that the sum of the methane and ethane obtained by calculation is over 100, and the nitrogen a minus quantity. To overcome these defects, use is made of the following method in which the contraction on explosion and on absorption of the carbon dioxide is treated as one known factor and the oxygen entering into combination the other factor.

Percentage of Oxygen in Commercial Oxygen

Commercially pure oxygen is used instead of the oxygen and nitrogen mixture of previous methods. This practice is necessary on account of the great amount of oxygen required for combustion. The determination of the percentage of oxygen is made by exploding a large quantity of it with hydrogen and noting the resultant contraction, of which one-third equals the oxygen. The determination is best accomplished in the following manner: about 100 cc. of pure hydrogen are forced into the burette, the capillary is filled with water from the explosion pipette, a reading is taken, and the gas is forced into the explosion pipette until the water level is at zero; about 100 cc. more hydrogen are introduced, and a reading is taken; the gas is then forced into the explosion pipette until the water level is again at zero. About 60-65 cc. oxygen are then added, a reading is taken, and 15 cc. portions are successively introduced into the explosion pipette and exploded, the gases being well mixed before the last explosion. After the final explosion, the residue is drawn over, the capillary being filled with water, and a reading is taken. One-third of the contraction is oxygen, from which the percentage can be calculated.

Determination of Carbon Dioxide

Exactly 100 cc. are forced into the burette from the sampling tube, as described previously. A reading is taken, and the gas is passed through the potassium hydroxide pipette for the absorption of carbon dioxide, then returned to the burette, and the capillary filled with water from the explosion pipette. A reading is taken; the contraction in volume is the percentage of carbon dioxide.

Determination of Illuminants

The use of fuming sulphuric acid is not advisable here as it absorbs the higher members of the paraffine group. In its place is substituted a pipette containing a 1 per cent solution of palladium chloride. The gas is passed three times through this solution and returned to the burette, the contraction being illuminants, thylene and its homologues. The contraction in volume would also include hydrogen and carbon monoxide, if present; however, the rate of absorption of these gases is comparatively slow. They are generally absent, and their absence is proved by the method described later. One passage of natural gas through fuming sulphuric acid gives about the same contraction as the method described herein, but repeated passages take out more and more of the paraffine. No definite result is obtained.

Determination of Oxygen

After absorption of illuminants, the gas is passed into the phosphorus pipette for the absorption of oxygen, and while it is there, the requisite amount of oxygen is measured in the burette and transferred to the explosion pipette. The gas in the phosphorus pipette is then returned to the burette, and the contraction due to absorption of oxygen is noted.

Determination of Methane and Ethane

The gas residue consists, besides the small quantity of nitrogen, of methane, ethane and perhaps other higher homologues. It is impossible by any method to determine more than two gases of the paraffine group by combustion, and the gases are assumed to consist of methane and ethane. No error is introduced by this assumption, as proven later.

While the gas is in the phosphorus pipette as described above, oxygen is drawn into the burette to its capacity, the capillary is filled with water, and a reading is taken. The gas is then forced into the explosion pipette until the water is at the zero mark, the capillary containing gas. The right hand capillary tube is flushed with water, and 50 cc. of air are drawn into the burette and measured; about 15 cc. oxygen (sufficient to make the total 122 cc.) are then added, and the gas is forced into the explosion pipette. The right hand capillary is flushed out, and the gas in the phosphorus pipette is drawn into the burette and measured, as described under Determination of Oxygen. One-half the residue is discarded or reserved in the phosphorus pipette. About 10 cc. of the half reserved for analysis are forced into the explosion pipette and exploded. This operation is repeated with successive portions of the gas until the last is added, when the gases are thoroughly mixed before explosion. The resultant gas is very rich in carbon dioxide, which, if the gas were passed into the burette, might be absorbed by the water. Later on this dissolved carbon dioxide may be given off by the water. Therefore, a compressor is placed on the rubber tubing from the burette to the bottle, and the gas in the explosion pipette is forced to bubble through the potassium hydroxide pipette by raising the bottle connected to the explosion pipette. After the gas has been passed several times it is transferred to the burette, and a reading is taken. The sum of the diluted oxygen added and the gas residue taken for explosion, minus the volume remaining after the absorption of carbon dioxide, is Contraction "A." Hydrogen is then added to the capacity of the burette, a reading is taken, and the gases are passed into the explosion pipette, well mixed and exploded. The residue is passed into the burette and measured; the decrease in volume is Contraction "C."

From the above contractions ("A" and "C") and from

*From the second edition of the U. S. Steel Coproration's "Methods for the Technical Sampling and Analysis of Gases."

a knowledge of the amount of oxygen in the commercial oxygen, the methane and ethane may be calculated. The reactions of burning methane and ethane are as follows:

$$CH_4 + 2O_2 = CO_2 + 2H_2O.$$
$$2C_2H_6 + 7O_2 = 4CO_2 + 6H_2O$$

From these reactions it is seen that the total contraction on combustion and absorption of methane and ethane are 3 and 9/2 times the volume of the respective gases; or that "A" $= 3CH_4 + 9/2C_2H_6$. Likewise the oxygen consumed (Oc) is 2 and 7/2 times the volume of the respective gases; or $Oc = 2CH_4 + 7/2C_2H_6$. Also it is evident that the oxygen consumed equals the oxygen added (Oa) minus the oxygen entering the second explosion, which is 1/C. or $Oc = 1/3C$.

From these equations the following formulæ are derived:

$$CH_4 = \tfrac{7}{8}\,A + C - 3Oa.$$
$$C_2H_6 = (A + 1/3C - Oa) - CH_4.$$

Example—Data

BURETTE READINGS

	Purity of Oxygen	
Hydrogen added	0.0 99.0	99.0 Hydrogen added.
Hydrogen added	0.0 96.8	96.8 Hydrogen added.
Commercial Oxygen added	0.0	61.8 Commercial Oxygen added.
Explosion	61.8 257.6 Total volume. 77.0 Residue. 77.0 180.6 Contraction. 60.2½ Contraction or Oxygen.	

60.2 — 61.8 = 97.4% Oxygen in Commercial Oxygen.

	Gas Analysis	
	100.0	
Potassium Hydroxide	99.8	0.2% Carbon Dioxide.
Palladium Chloride	99.4	0.4% Illuminants.
Stick Phosphorus	99.4	0.0% Oxygen.
	49.7	½ Residue.

	Gas Analysis		Oxygen
	0.0		
Commercial Oxygen	99.4	99.4 Commercial Oxygen	96.82
	0.0		
Air	50.0	50.0 Air	10.45
Commercial Oxygen		15.0 Commercial Oxygen	14.61
	65.0		121.88
		49.7 ½ Residue.	
		214.1 Total volume.	
Explosion and Absorption		53.9 Residue.	
	53.9	160.2 Contraction "A."	
Hydrogen added	98.4		
Explosion	67.7	30.7 Contraction "C."	

Calculations

160.2	Contraction A.
× 7	
3/1121.4	
373.8	½ Contraction A.
30.7	Contraction C.
404.5	
365.64	3 × Oxygen added.
38.86	Methane.
160.2	Contraction A.
10.23	½ Contraction C.
170.43	
121.88	Oxygen added.
48.55	Total Combustibles.
38.86	Methane.
9.69	Ethane.

Analysis	
Carbon Dioxide	0.2%
Illuminants	0.4%
Oxygen	0.0%
Methane	77.7%
Ethane	19.4%
Nitrogen	2.3%
	100.0%

Determination of Hydrogen and Carbon Monoxide

These gases are generally absent. If present, they reduce palladium chloride somewhat slowly, water and carbon dioxide being formed. If the diminution in volume caused by the passage of the gas through palladium chloride is considerable, the presence of hydrogen or carbon monoxide would be indicated, in which case their determination is advisable. For this purpose, the apparatus for supplying hydrogen is disconnected, and a palladium tube is connected to the end of the gas apparatus—the other end of the palladium tube is connected to an absorption pipette containing water. The palladium tube is immersed in a beaker of water at 90-100 degrees C., and oxygen is passed through the tube to oxidize any hydrogen present. The water is drawn to a specified point in the stem of the absorption pipette, and the capillary tube of the apparatus is filled with water from the explosion pipette. Fifty cc. of natural gas are then introduced into the burette and measured, the carbon dioxide is removed, and the gas is passed through fuming sulphuric acid. About 10 cc. of oxygen are added, and a reading is taken. The gases are then passed back and forth through the palladium tube, which is immersed in hot water at first and then in cold water to cool the gas. The gas is finally brought back into the burette, the water in the pipett ebeing at the previous level, and a reading is taken. The decrease in volume is noted as Contraction "a." The gases are then passed into potassium hydroxide, drawn back and meassured; the diminution in volume is Contraction "b." From a study of the contractions formed in the combustion of carbon monoxide and hydrogen, it is seen that

$$CO = b;\ H_2 = (2a - b) \div 3.$$

Error in Assuming the Gas to Be Methane and Ethane

The basis of the determination is in reality the volume of combustible gas (equal to A—Oxygen consumed) and the oxygen necessary for combustion (Oxygen consumed = Oxygen added — ½C.). Both are accurately determined, consequently the combustibles present and the amount of air necessary for their combustion as calculated from the analysis is correct. The carbon dioxide formed on combustion has not been determined but can be calculated for any and all paraffines which have the general formula C_nH_{2n+2}. If n represents the number of carbon atoms in the molecule, and p the total volume of paraffines, then, by reasoning analogous to that given when the formula were derived, np equals (Oxygen consumed — ½ A). But np equals the carbon dioxide and is independent of any particular paraffines that may be assumed to be present, therefore, the carbon dioxide formed on the combustion of the gas, as calculated from the analysis, is correct. As regards the heat value calculated from the analysis, Thomson has shown that the heat value of a paraffine is equal to K + nD where K and D are constant factors. The heating value of the unabsorbed portions of natural gas then is (K + nD) p or Kp + Dnp. It has been shown that p and np are correct, depending upon the factors A, C and Oa. Therefore, the heating value of natural gas as calculated from the analysis is correct.

Charcoal Precipitation of Aurocyanide

A Description of the New Moore-Edmands Process With Discussion of the Underlying Theories

BY A. W. ALLEN

THE use of charcoal as a precipitant of gold from aurocyanide solution has never reached the point of importance where it might be considered as a serious rival to zinc. Lump charcoal was used in the early stages of the cyanide process on a commercial scale in Victoria, Australia; and has been adopted to a small extent elsewhere but without success. The only exception to this statement may be found in the case where gold from waste solution discharged from a cyanide plant to reduce fouling, or to prevent undue accumulation of liquor, is recovered by this method. Appreciable quantities of gold may also be saved, by the use of charcoal, from decanted solution from slime tailing dams, or where the seepage from tailing-filled stopes carries small amounts of dissolved metal. In such instances the results may be termed satisfactory only insomuch as an amount of gold is recovered that would otherwise be lost. Effort is seldom made to effect a complete saving, the equipment is usually neglected during the month and attention only paid to it when the urgent need of an addition to the gold yield is in evidence.

On a commercial scale the substitution of lump charcoal for zinc could not be considered satisfactory from any standpoint. A large amount of charcoal is needed to recover a small amount of gold. The product, even after burning, is bulky; and the gold content of the ash to be smelted is exceedingly low. The efficiency of the process, unless an enormous amount of charcoal is used, is unsatisfactory. No progress in the adaptation of charcoal as a means of recovering gold from cyanide solution has been made for many years; and its use in this connection has been considered as unfeasible as the cyanide process itself was viewed before MacArthur and Forrest invented a method of procedure capable of practical application.

THE WORK OF MOORE AND EDMANDS

A noteworthy advance is now due to the efforts and ingenuity of K. Byron Moore and H. R. Edmands who have resurrected the question and, after exhaustive laboratory erperiments, have perfected a system of precipitation with charcoal slime which apparently leaves little to be desired. The method has been finally adopted at the Yuanmi mine, Western Australia, and is also being practised in South Africa. In the former case a foul and complicated cyanide solution containing antimony and arsenic is successfully freed of its gold. With zinc precipitation there was trouble and loss from high tail solution, the cost of zinc was considerable, and, even after extensive refining, the bullion was comparatively low grade. By the adoption of the new charcoal method the effluent from the extractors may now be reduced to contain but a trace of gold. The bullion, after simple smelting, is valued at about $20 per oz., as compared with about $17 per oz. for a similar product after zinc precipitation. The saving in the cost of recovery of the gold is about 25 cents per ton of ore treated.

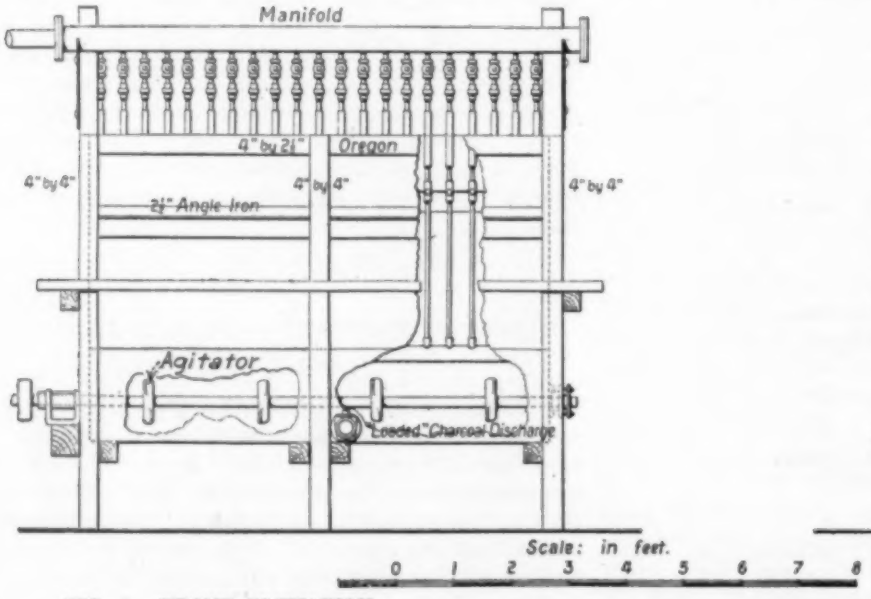

FIG. 1. FRONT ELEVATION

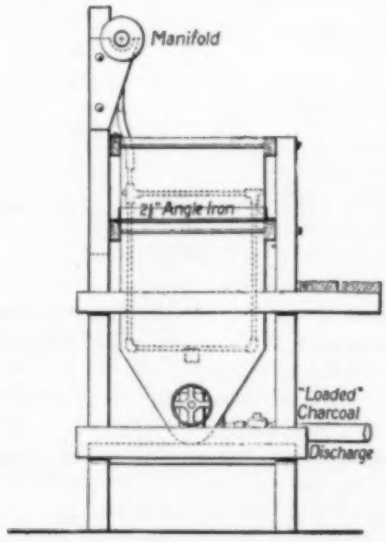

FIG. 2. END ELEVATION

MOORE-EDMANDS EXTRACTOR

After a year of operation a statement of result was published by H. G. Walton.[1] No fouling agent similar to the double zinc cyanide appears in the solution; and such a result would automatically effect a saving in cyanide consequent on a permissible reduction of cyanide strength in the solution. No figures are available in this connection, but in a later publication by H. R. Edmands[2] it is to be noted from comparative results of the use of zinc dust and charcoal that the necessary cyanide strength in the case of zinc was five times as much as when charcoal was used.

[1]Report of the Department of Mines of West Australia, 1916.
[2]Bull. Inst. Min. & Met., London, March, 1918.

The principal features of the new Moore-Edmands process are as follows:

Preparation of Charcoal

The charcoal used is water-quenched when red-hot, washed, and wet ground in a small ball-mill to as fine a product as possible.

Moore-Edmands Extractor

A special form of extractor is used consisting of a miniature vacuum-filter of (what is known outside Australia as) the Butters type. The suspended frames are 2 ft. 3 in. x 2 ft. 9 in., and there are 21 to each extractor. The filter media are, respectively, coconut matting as a support, filter canvas, and an outer protective layer of calico. The extractor is shown in Figs. 1 and 2 and contains four agitators in the bottom of the hopper, attached to a horizontal shaft.

Method of Operation

Solution and charcoal pulp are pumped to an extractor and the vacuum started as soon as the leaves are properly submerged. Fresh solution is added concurrently with the formation and maintenance of cake, and the supply of liquor is such that a continuous stream passes through the charcoal. The propellers are kept in operation and percolation continued for 24 hours, or some other pre-determined time. The vacuum is then released, the charcoal cakes dropped to the hopper bottom of the extractor, emulsified, and re-formed on the filter leaves by the application of vacuum. This cycle of operations is continued at intervals as long as the charcoal possesses sufficient activity to precipitate the gold. The extractors are worked in series, the one whose cakes are approaching gold saturation receiving the richest solution, the tailing from this going to the second extractor, and being finally impoverished by contact with fresh charcoal.

Washing of Charcoal-Gold Precipitate

The final emulsified charcoal pulp, loaded with gold, is delivered to a clean-up press, washed, and dried with compressed air.

Calcining

Burning of the charcoal is carried out in braziers, 18 in. x 18 in. x 18 in., and made of ½-in. aperture stout wire screening. The operation is carried out in a locked steel chamber and takes about 48 hours.

Smelting

The flux adopted is as follows:

Precipitate	100 parts
Borax	40 to 50 "
Sand	50 "
Salt	10 "

Plain graphite crucibles are used and have a long life.

Fineness of Bullion

A comparison of results with charcoal and zinc precipitation is as follows:

	Charcoal	Zinc
Gold	954.4 fine	825.2 fine
Silver	7.0	21.9
Base	38.6	152.9

Weight of Charcoal Required

Walton[3] states that 1 ton of charcoal will precipitate 770 oz. of gold by this method, and that the weight of calcined ash is about one-third of the original weight of the charcoal. Edmands[4] gives the percentage of gold in the calcined ash as from 10 to 14 per cent. The enormous increase in the precipitating power of charcoal by fine grinding is indicated by the fact that, by the old method of percolation through extractor boxes, 5 tons of charcoal was needed to precipitate about 700 oz. of gold.

The charcoal used at the Yuanmi mine is an otherwise waste product from producer-gas manufacture. The wood used is locally known as mulga scrub and is a variety of the acacia family which includes several wattles indigenous to Australia. It is possible that the character of the wood, which in some species contains a considerable amount of tannin, has a favorable effect on the final result. Different woods have widely different precipitating values when made into charcoal and used for the recovery of gold from cyanide solutions.

The sole drawback to the method appears to be the amount of material to be smelted. The actual smelting entails no difficulties and there is little corrosion of crucible. The latter might even be reduced by an alternative flux. In medium- or large-sized plants such low-grade precipitate is best smelted in large tilting furnaces—an arrangement permitting the periodic pouring of slag only, the gold being allowed to accumulate in the bottom of the crucible, where it refines. This method minimizes the temporary loss by shotting met with when small charges of gold are poured through a large bulk of cooling slag. The furnace also acts as a safe during night operations, when there is less available supervision, and when minimum handling of bullion is advisable.

Theory of Charcoal Precipitation

The various theories propounded to account for the action are as follows:

Occluded Oxygen Theory.—It has been suggested that an insoluble gold cyanide and sodium cyanate is formed.

Electro-Deposition Theory.—This theory assumes that gold is deposited as metal as the result of electrical action. It is disproved by the fact that there is no corresponding liberation of cyanide during precipitation.

Carbon Monoxide Theory.—The assumption that a chemical action takes place between the occluded carbon monoxide gas and the aurocyanide whereby a carbonyl aurocyanide, or other analagous compound, is formed has been widely accepted. Criticism of this theory must be mainly constructive and in opposition. All the asumptions are hypothetical and no parallel action is known with charcoal.

Adsorption.—The theory that the precipitation is due to a simple adsorption of aurocyanide—$KAu(CN)_2$—is supported by the following facts:

1. The loss of cyanide, by titration, agrees with theoretical considerations.
2. Precipitation efficiency varies inversely with the concentration of the solution, and a true absorption curve may be plotted from actual results.
3. Precipitation is proportionate to surface exposed, finer grinding giving better results.

[3] Ibid.
[4] Ibid.

4. Methods of preparation of the charcoal which drive off occluded gas (quenching when red-hot and wet grinding), and so increase surface energy of the charcoal, result in a more favorable action.
5. The addition of acid accelerates precipitation whereas alkali retards it. This is a parallel instance of the obstructive effects of hydroxyl as compared with hydrogen ions as demonstrated by Lachs and Michaelis[6] in connection with the adsorption of an aqueous solution of potassium chloride by charcoal.
6. The adsorbed gold compound is insoluble in ordinary solvents although released by the addition of a solution of different surface tension, such as a soluble sulphide—a parallel to the case where picric acid adsorbed on platinum may be released by alcohol, although unaffected by water, its natural solvent.

New York, N. Y.

Tariff Commission Conference on Antimony, Quicksilver and Tungsten

The United States Tariff Commission is now engaged in the systematic assembly of information on the various industries of the country, with a view to presenting it in well-digested form for the guidance of Congress. The Commission is receiving valuable assistance from manufacturers, merchants, consumers, and the public, and this co-operation is being continually extended and strengthened. Engineering societies and Government bureaus are consulted as the work progresses. Attention will be given to labor conditions.

A conference will be held at San Francisco in the Assembly Room of the Chamber of Commerce during the week of June 24th on antimony, quicksilver and tungsten ores and products, to which the producers, importers and consumers interested in these metals from all parts of the country will be invited. The conference is for the purpose of securing information in regard to disturbances and changes in these American industries. The topics to be discussed fall under three heads:

(1) The condition of the American industry before the war, in relation to foreign competition;
(2) The effect of the war on the industry;
(3) Competition with foreign producers after the war.

The conference will take the form of an inquiry into the effect of the war upon production, markets, plant expansion, increase in cost of materials and wages since 1914, and post-war competition—all of which will be considered in their bearing upon the tariff. Imports and exports, relative foreign and domestic costs of production of metals and products, and the adequacy of American ore deposits for domestic needs will be among the subjects discussed.

A separate hearing on tungsten will be held in Denver, Colorado, on Monday, June 17. This meeting will be opened at 10 a.m. in the United States District Court Room at the new Post-Office Building, and the proceedings will be of the same general nature as at the California conference. At San Francisco, the hearing on antimony is to be called at 10 a.m., Monday, June 24; quicksilver Wednesday, June 26; tungsten Friday, June 28.

The Commission hopes that the meeting may fairly represent the various interests involved. General notice and invitation is being sent to those concerned.

[6]Zeit Electrochemie, 1911.

Determining Copper Minerals in Partly Oxidized Ores

By Felix Cremer

THE article of Charles E. Van Barneveld and Edmund S. Leaver[1] on the determination of so-called oxides in mixed ores, gives me an opportunity to state my own ideas on the subject and review a few facts connected with my work in that direction. In January, 1917, I took charge of the first experimental work to be conducted by the Andes Copper Mining Company at Potrerillos, Chile, for the study of the best method of treating the ore from their large copper deposit. This consists of a great mass of eruptive rock, variously called, syenite, rhyolite and porphyry, ejected through a limerock formation and greatly altered in texture and composition in most places, thus giving the whole a very complex and heterogeneous structure. One of the features of the decomposition of these rocks has been the percolation of copper-carrying solutions, originating with some of the rocks of a primary character, and resulting in the deposition of new copper minerals in local deposits of irregular shape, size, structure, composition and richness. While in some places the processes of repeated solution and precipitation resulted in deposits of very high-grade ore, of more or less limited extent, in other places the elementary rocks do not seem to carry more than traces of copper.

Some of the richest ore, near the surface, has been extracted in the past by the natives, but this ceased to be profitable where it became necessary to do much dead work to find the rich ore in so much low-grade material. Therefore, nothing remained but to mine the ore by a more or less selective process on a large scale, the problem being to conduct the operations in such a way that a sufficiently low cost would allow portions of the deposit to be handled in bulk, i.e., without any attempt at descriminating, locally, between rich and poor ore, and then to find these portions and outline their boundaries.

Copper Minerals in Potrerillos Deposit

The principal copper minerals identified in this deposit are chalcorite, chalcopyrite, some bornite and covellite, chrysocolla, some malachite, atacamite, brochantite, cuprite and native copper; but it is important to observe, for the possible treatment of the oxidized ore by film-sulphidizing and flotation, that little of the silicates of copper, constituting the main portion of the oxidized minerals, appear strictly as chrysocolla, but simply as copper-impregnated quartz, the copper being preserved in all proportions, from a slight greenish stain to the correct percentage corresponding to the mineral chrysocolla.

The relative amounts of sulphide and oxides in the deposit, estimated from the reports of the drill men—these again basing their opinion on the evidence from panned drill-hole samples—is about half and half; but as this process of arriving at the facts is not as precise as might be desired, the figure is subject to more or less correction. This, however, is not as simple a matter as it would seem at first glance, for reasons which will become apparent from what follows:

[1]This journal, Feb. 18, 1918, p. 203.

At the time I commenced to work on this matter, two methods of determining the so-called oxide copper, namely, were known to be in use, heating the sample with a 5 per cent solution of sulphuric acid, the one method calling for a 24-hour treatment at room temperature and the other for one-hour treatment near the boiling point. The ammonia method, mentioned by Van Barneveld and Leaver, had not come to our knowledge, nor would have inspired much faith in its utility on chemical considerations, and does not seem to be much in use. The other two had been the classical methods for a number of years in all the leading American copper mines, at home and abroad, where the grave objections to them did not seem to have been fully realized, as no serious attempt was made to devise a better method.

Test of Sulphuric Acid Method

My first step, in putting the H_2SO_4 method to a test, was to try it on a high-grade oxidized ore, carrying about 20 per cent cuprite and 10 per cent chrysocolla, which showed at a glance that the copper from the cuprite was not all dissolved, but that part of it remained insoluble as metallic copper. This would naturally appear in the assay returns as sulphide copper, in the same manner as all native copper would appear in the same column.

When this weakness of the method was discovered, an attempt was made to find a solvent for this metallic copper. While experimenting along that line it was noticed, under the microscope, that few if any samples delivered to the laboratory were free of metallic iron, which was then identified also by ocular inspection of the pannings from the samples. In some instances these carried practically nothing but iron, when the drillers had attempted to straighten out a crooked hole by filling the bottom up with tin-cans and similar material. Of course this added another error to the determination, operating in the same sense as the two first mentioned, by precipitating a certain amount of copper from that taken into solution by the acid.

Against these three sources of error, all tending to show higher sulphides at the expense of the oxides, there is the solubility of the sulphides by sulphuric acid mentioned in the article referred to, which escaped our notice as the method was soon discarded after its defects had become known. This probably explains some of the erratic returns obtained previously which could not be accounted for by the then known facts. In regard to this solubility of the sulphides in dilute H_2SO_4, I am not quite convinced that this is due to the direct action of the reagent. In some cases of a similar nature we have traced the apparent attack of sulphuric acid on sulphides to the presence of chlorides and nitrates in the ore, and it might not be amiss to test this point by repeating Messrs. Van Barneveld and Leaver's experiments on an ore thoroughly leached with water previous to the addition of the acid, which, of course, must also be free of chlorine and nitric acid.

Unreliability of Sulphuric Acid Method

When it began to be realized how utterly unreliable the H_2SO_4 method was for the determination of oxide copper, steps were taken to find a better method. For a while our hopes were placed on hydrogen peroxide, which, under the microscope had been found to dissolve the metallic copper in dilute H_2SO_4, and proved afterwards to attack natural sulphides only slightly. Artificial sulphides, however, i.e., those precipitated from copper solutions by H_2S, were freely attacked, and since this method would not have solved the metallic-iron difficulty anyhow, it was soon abandoned.

On the other hand, phosphoric acid, which also proved a good solvent for all carbonates and silicates, did not attack the sulphides (natural or artificial), nor were its copper salts affected by metallic iron, but neither it did not dissolve metallic copper. In searching, therefore, for a solvent for this, it was found in ammonium chloride which dissolves metallic copper more readily than any other reagent known to us. Thus a combination of phosphoric acid and ammonium chloride suggested itself and was tried on a variety of our ores, with results that seem to place the method on a par, at least, with the sodium tartrate method of Hunt & Thurston and the sulphur dioxide method of Van Barneveld and Leaver. The latter method was not known to us before my recent separation from the Andes Copper Mining Co., and therefore could not be tested, but with the tartrate and phosphoric acid methods a number of parallel determinations were made which seem to indicate that there is no difference between the two for low-grade ores as far as results are concerned, and that, therefore, the question of preference between the two methods would have to be settled on points of manipulation.

Insufficient Grinding Caused Discrepancies

For some time unaccountable discrepancies in the results from the same sample with the phosphoric acid method, especially with high-grade ores, seemed to throw a doubt on the value of the same, but it appears that all can be traced to an insufficient comminution of the sample. The standard practice in our laboratory had been to crush to 80-mesh, and I believe with Messrs. Van Barneveld and Leaver that too much attention to this point cannot be given, the safest course being to grind all samples for these determinations to 150-mesh.

Unfortunately time did not permit these tests to be carried to a definite conclusion in regard to this and other points, and the writer would be glad to see the method subjected to a searching scrutiny so as to determine positively which of the three proposed will be the most useful for the chemist.

Among the difficulties that presented themselves in the operation of the method early in its history one was due to the peculiar conditions prevailing at the Potrerillos laboratory. This was not equipped with an electrolytic precipitation system for lack of current, and all copper determinations had to be made by volumetric methods, the cyanide for ordinary purposes and the iodide for more accurate work, the latter being too tedious for application to a large number of assays. After titration with the cyanide, however, the phosphate solution showed a decidedly yellowish tint, which greatly interfered with a sharp endpoint. After some trials with various materials Mr. L. F. Clark, our chief chemist, who in all our experimental work has been of the greatest assistance owing to his resourcefulness

and originality in solving chemical problems, found that the addition of some burnt lime (from our lime kiln), after solution of the copper had been effected and before the contents of the flask had been made ammoniacal completely removed the objectionable yellow color and left a crystal-clear liquid with which to finish the titration.

Improved Laboratory Method of Determining Copper

The operation of this method is exceedingly simple. One gram of the sample is weighed and introduced into an ordinary 500-c.c. flask with flat bottom, covered with 20 c.c. of a 15 per cent H_3PO_4 solution and an equal amount of a 20 per cent NH_4Cl solution, and boiled gently for some ten minutes. After cooling somewhat, a pinch (mustardspoonful) of burnt lime was given, the flask thoroughly shaken, and 25 c.c. strong ammonia water added. This was given another short boil, the ammoniacal copper solution filtered off from the residue, allowed to cool and titrated in the ordinary way with cyanide solution. Occasional check determinations with the iodide method gave concordant results.

The exact amounts of H_3PO_4, NH_4Cl and NH_3, as also the proper strength of the solutions could not be worked out in the allotted time, but the proportions given above answered well for all ordinary samples, up to 2 per cent and 3 per cent oxide copper. Possibly they might be reduced to advantage. On very high-grade oxide ore, say 30 per cent, to the best of my recollection a second treatment, after filtering off the dissolved copper, still yielded appreciable amounts, though I am inclined to believe that with sufficiently fine grinding this may not be the case.

Several trials with this mixture on various sulphides, both natural and artificial, to test their solubility, yielded negative results.

What Is "Oxide" Copper?

We now come to the question of what we are trying to accomplish by devising a method for the determination of oxide copper. What is oxide copper? And, is it really the oxide copper that we are endeavoring to determine? Evidently, native copper is not oxide copper, though we purposely are trying to find a way that will include it in the results, and are disappointed that the H_2SO_4 method does not do so. It is, then, to say the least, misleading to call these oxide copper determinations.

Similarly, only by some stretch of the imagination can we call the carbonates, silicates, basic sulphates and oxychlorides, "oxides." It would be better to include all of these, together with the real oxides (cuprite and melaconite) and native copper under the term of "oxidized copper." But, do we really want to know the amount of all this "oxidized copper" in technical determinations? It may be useful, occasionally, for geological or similar objects, but I know of no metallurgical process where such a knowledge could be of any utility and that, after all, should be the criterion by which to judge the value of a method. And so we come to the conclusion that each metallurgical process should have its own laboratory method, and give it its distinctive name to avoid confusion.

Effect of Iron on Drill-Samples

For instance, in the simple leaching of ores with sulphuric acid: If it were not for the presence of metallic iron in the samples from the drill-holes and bucking board, there could be no better method for the laboratory than treatment with dilute H_2SO_4, as it only represents the large scale operations *en miniature*. Unless, therefore, the samples come from other places than drill-holes and are not reduced to powder in contact with iron, a method must be found that will eliminate this iron, either by dissolving it in something that will not attack the copper oxides or some other indirect way. Removal of the iron with a magnet does not seem feasible without losing at the same time much of the sample, even if one had the assurance that all iron could thus be extracted. But, it should be possible to replace the iron completely by copper with $CuSO_4$ and then apply the dilute H_2SO_4 which will, of course, leave untouched this new copper as well as that from cuprite and the native copper, thus furnishing an accurate measure of what the leaching operations should yield. Copper-ammonium chloride might possibly be used to advantage in place of copper sulphate, provided it could be determined positively that it had no effect on the copper oxides.

Each Process Requires Special Method of Determining Copper

But, simple leaching is not the only process copper mines have to deal with. There is flotation, in acid, neutral and alkaline pulp, in sweet water and in sea-water, and with all kinds of chemical agents or "drops." None of the methods touched upon in this review will help us here; each combination of processes will require one of its own, and some will prove eventually none too simple.

Take, for instance, oil flotation in acid pulp. What we need to know in this case is how much of the copper in the form of floatable sulphides is in the ore, how much in the concentrate, and how much in the tailing. In order to do this we have first to determine the total copper. Then we have to find out by some such method as described above how much of it goes into solution in the acid, leaving us, by subtraction, the amount that should be in the form of sulphide and therefore appear in the froth—provided the metallic copper acts as sulphide in that respect as some people assert and I believe to be the case, but which many people deny. If it does not, then we have to try to determine this amount of metallic copper, perhaps by amalgamation, and make allowance for it, not forgetting, in making our metallurgical balance sheet that some portion of the oxidized copper minerals must necessarily be tangled up in the gangue floated with the sulphides.

And so it will be with floating in an alkaline pulp, where the situation may, or may not be still more complicated, according to circumstances. And so it will be also with all other processes, already in use, like the combined leaching and flotation, ammonia process, etc., or those still to come, each one requiring its own laboratory methods.

Santiago de Chile

Chemistry in the Petroleum Industry*

Commercial Development—Gasoline by the Burton Process and Scientific Aspects

By William H. Burton, Ph.D.

FOUR years ago we assembled to witness the awarding of the Willard Gibbs Medal to Dr. Ira Remsen, of Johns Hopkins University, and one year ago we met for the same purpose in the case of Prof. Edward W. Morley, of Western Reserve University. Both of these gentlemen were honored preceptors of mine, and it was indeed a great pleasure to me to be present on those occasions. I never thought, however, that I would ever be the fortunate recipient of the Willard Gibbs Medal, but the unexpected and improbable very often occurs, and it is so in my case. I therefore hasten to extend to the Chicago Section of the American Chemical Society my deepest appreciation of the honor it has conferred upon me. This event reminds me of a most prominent feature in Dr. Remsen's course of instruction, namely, that the best preparation for a career in technical chemistry is thorough training in the pure science, and I was equally impressed with the introductory sentence of Dr. Morley's address last year, when he said "The best incentive for research work is the work itself." Both of these great teachers have exemplified these principles most happily in their professional careers, and I trust you will find my remarks thoroughly imbued with the influence of their invaluable instruction.

Early History of Petroleum

In considering the part that chemistry has played in the petroleum industry, it might not be unwise to review, briefly, the early history of the industry in this country. You have all heard of the first oil well, drilled by Col. E. L. Drake, near Titusville, Pa., in 1859. Prior to that time petroleum was found in small quantities floating on the surface of springs or small streams of water in western Pennsylvania, and this oil was claimed by the Indians to have marvelous curative properties in the treatment of every manner of disease. The white man, with true commercial instinct, sold the oil in bottles as a general cure-all. The demand for the oil exceeded the supply, and Colonel Drake conceived the idea that if the oil came to the surface of the springs and rivers, there must be large quantities of it in the underlying strata of the earth. He, therefore, with the most primitive machinery, drilled a well near Oil Creek, in western Pennsylvania, and before he had proceeded 100 feet into the ground the oil appeared in such large volume that it was difficult to take care of it.

At that time there was a great need for a cheap and convenient illuminating material to supplant the expensive animal and vegetable oils which were used for that purpose. Samples of petroleum (prior to Drake's work) had been sent to Professor Silliman, of Yale College, who distilled the oil and made separations according to the boiling points of the various fractions. In his report he stated that portions of these distillates might well be utilized for illuminating purposes. The promoters of the oil business acted upon Professor Silliman's suggestions, and this was the inception of the petroleum refining industry in this country.

Chemical Problems Arise

For a great many years after Professor Silliman's investigation chemistry played a very small part in the practical workings of the refining of petroleum. The refiner learned to treat the illuminating oil distillate with strong sulphuric acid and alkalis, which improved the character of it somewhat, but the methods of refining were crude and wasteful. The only portions of the petroleum which were used at first comprised the fractions boiling between 100 and 300° C., which constituted somewhat over 50 per cent. of the total mass of the crude oil. The low boiling fractions which we now comprise in the generic term of "naphthas" were thrown away, as were also the high boiling residues, called "tar." The tar, however, was soon utilized for preparing lubricating oils of very indifferent quality. It was not until about 1870, when M. L. Hull, of Cleveland, Ohio, first devised the so-called "vapor stove," that the naphtha fractions of the oil were utilized. But even then the uses for the naphtha fractions did not cause a demand equal to the supply, and much of the naphtha was wasted, a common practice being to throw it into the creeks and rivers, where it evaporated. Millions of gallons of this material, now indispensable for automobiles, were thus lost.

These conditions continued until 1885. Up to this time practically the sole source of petroleum in America was western Pennsylvania. But in 1885, or '86, petroleum was found in western and northwestern Ohio, near the town of Lima, and the fact that this oil contained from one-half of one per cent. to one per cent. of sulphur attracted immediate attention. The ordinary refining methods of distillation and treatment with sulphuric acid and alkali were found to be totally inadequate to secure refined illuminating oils of suitable quality. Therefore, the industry turned to the chemist to solve the problem of extracting the sulphur, and producing satisfactory products.

No Petroleum Chemists

It is very curious that from the early days of the industry until the discovery of Lima oil, there seemed to have been prejudice on the part of practical oil men against the chemical fraternity. Why this should have been so is not entirely clear, but I think that one reason might be the fact that manufacturers frequently called upon chemists of general training to solve some particular problem connected with their business, ignoring the fact that the chemist probably had had no practical refining experience. The chemist therefore probably offered suggestions which were totally impracticable and the manufacturer, seeing this fact, was not particularly impressed with the chemical profession as a possible aid to his business. Whatever the reasons may have been, it was a fact that in 1885, with the discovery of Lima oil, there was scarcely one trained petroleum chemist in the United States. The oil refiners, however, were forced to turn to the chemical profession for the solution of their problems, and the chemists had to become somewhat trained in the refining business before they could offer a practical solution for the elimination of sulphur from the oil. This was the starting point for a better feeling between the chemical profession and the petroleum in-

*Address by William H. Burton, Ph.D., before the Chicago Section of the American Chemical Society upon being awarded the Willard Gibbs medal.

dustry, and from that time, more and more chemists have been employed in the refining industry, until today the larger refineries depend almost entirely upon chemists to manage, not only the refinery as a whole, but the various departments of the same.

Training Chemists

In selecting a subject for an address on an occasion like this, it is customary for the candidate to choose as his subject the line of work the results of which have presumably been the reason for his being selected, and I have followed the usual procedure. It is perhaps difficult to describe the work that has been done without appearing to be somewhat boastful. However, the remainder of my remarks will be devoted largely to the results secured by the Chemical Department of the Standard Oil Company of Indiana, and I shall try to recount, briefly, the facts concerning those things which have been accomplished, and eliminate, so far as possible, the personal equation. I entered the employ of the Standard Oil Company nearly thirty years ago, at the time that the Lima oil problem was very much in evidence, and it was perfectly clear that there was a great field for chemical activity in the petroleum industry, provided the refining companies were willing to educate the chemist in the business, before expecting that the chemist would be of much value to them. The Standard Oil Company signified this willingness, and from 1890 until the present time there have been a great many chemists employed by that company, most of them being in its employ today, some as active chemists, some as general managers, and some as managers of various departments. The result has been that the refining of petroleum, instead of being a haphazard process, has been largely systematized and improved, so that when we do certain things we feel confident we will secure certain results, and the great variety of useful products made from Mid-Continent petroleum today indicate the part that chemistry has played in the petroleum industry.

The Gasoline Problem

As I indicated a few minutes ago, in the early days the supply of low boiling fractions of petroleum were largely in excess of the demand. This condition of things existed from the inception of the business until the invention of the internal combustion engine. With the advent of this machine, the demand for low boiling products, included in the commonly used name of "gasoline," became tremendous. To illustrate: In 1900 our Company was able to sell only one million barrels of naphtha products. It could have made much more, but there was no demand for it. You will recall that the automobile was devised about that time, and although the use of it grew slowly, we could see a constantly increasing demand for naphtha products to run these machines, until by the year 1910 the demand had more than trebled, and it was perfectly obvious that something would have to be done to increase the supply of these products.

In those days, the average yields of various products of petroleum were about as follows:

	Per Cent.
Naphtha products	18
Kerosene or illuminating products	30
Lubricating products	10
Loss	3

leaving about 40 per cent., which was sold for gas making or fuel purposes in lieu of coal. It was clear that the problem was to convert the high boiling fractions existing in the fuel and gas oil into low boiling fractions needed by the internal combustion engine. It has long been known that superheating the vapors of petroleum at atmospheric pressure caused dissociation of the molecules, producing very low boiling fractions and very high boiling fractions, as is evidenced by the ordinary Pintsch gas, with which you are all familiar, but the low boiling fractions produced by these superheating methods are not suitable for internal combustion engines, and the losses due to fixed gases are very great. It was found that anhydrous aluminum chloride exerted a very marked effect upon the high boiling fractions, converting some of them into low boiling fractions entirely suitable for automobile purposes, but the very high first cost of the aluminum chloride, together with the fact that to make the process successful an inexpensive method must be devised for restoring the aluminum chloride, rendered this process out of the question. We worked for almost two years trying to devise a practicable method for securing this most desirable result, first by superheating and dissociation at high temperatures, but at atmospheric pressure, and secondly, by the employment of various reagents; but our efforts were not successful; on the other hand, we met failure in every direction.

The Burton Process

It had been known for a long time that distillation of petroleum products under pressure resulted in their dissociation and production of some low boiling fractions and some high boiling fractions, but this process never had been applied in a practical way because to a practical refiner the distillation of oils under high pressures did not appeal, owing to the extreme hazard due to explosions and fires; but having tried everything else that suggested itself, we decided to attack the problem from the pressure distillation standpoint.

To the layman, distilling oils under pressure would present no particular difficulty. The distillation of water is done every day in our steam boilers, and why should one fear to do it in the case of oil? But when you consider that the distillation must take place at temperatures ranging from 350 to 450° C., where the tensile strength of steel begins to diminish very rapidly, and when you consider that steel, at such temperatures, in the presence of carbonaceous matter (and even free carbon, which often comes as the result of pressure distillation), is very likely to absorb such carbon, become crystalline and lose its tensile strength, you can readily see why the practical refiner shivered at the prospect of doing work in this way. We consulted refiners who had been in the business a great many years. We advised with mechanical engineers for whatever suggestions they might offer, and it must be confessed we did not receive very much encouragement. Since we found, early in our work, that we would require a pressure of over five atmospheres, you can easily see that we approached with considerable respect the problem of building practical apparatus that would stand this pressure in actual daily service. One refiner doubted the practicability of carrying over one pound pressure, another refiner suggested the probability of

explosions, due to polymerization of the vapors under heat and pressure, such as occur when acetylene is compressed. However, we were able to secure a very liberal sum of money to try the scheme on a large scale, and the worst that could happen would be to burn up our plant and fail in our efforts. So we went ahead.

The first large still we built had a charging capacity of 6,000 gallons of heavy oil, and about the first difficulty we encountered was serious leaks around the rivet heads and along the seams. The workmanship in building the still was good and it would have been satisfactory as a steam boiler. We found that oil, at high temperatures and pressures, leaks worse than water, and a leak always causes a fire of an intensity directly proportional to the amount of the leak. It was difficult at first to secure boilermakers who would calk these leaks while the still was under pressure. In many cases when we calked one leak another would form. Finally nature came to our aid and we were gratified to observe that as the still continued in service the leaks became less serious. The oil carbonized under the influence of the high temperature and the carbon deposits stopped the leaks.

There were many puzzling problems to be solved. We had to devise a safety valve that would operate freely in spite of the intense heat and presence of carbonaceous matter. The entire apparatus had to be constructed in such a way as to insure ease of operation and freedom from excessive repairs. Distilling oils under pressure always results in the production of so-called "fixed gases." The disposition of these gases, at first, was troublesome. We found that in some cases the heavy oil with which we started evolved more gas than was needed to maintain the desired pressure in the apparatus, whereas other oils evolved an insufficient amount of gas for this purpose. This was an embarrassing situation, but we converted an obstacle into an aid by arranging a large number of stills in parallel so that the superfluous gases from some stills were conducted to others that needed them and this plan gave us a perfect method for securing uniform pressure and control—a most essential feature in the work.

The first large still we built, as I have mentioned, had a capacity of 6,000 gallons, and by starting with fuel oil products having boiling points ranging from 200 to 350° C., we were able to secure a very substantial yield of a product having boiling points ranging from 50° C. up to 200° C., and to our great gratification the losses incurred thereby were trifling, averaging less than three per cent. We were astonished, also, to find that the high boiling residues thus produced yielded a product almost identical with the natural asphalt which is mined in large quantities in the island of Trinidad. Evidently we are doing artificially what Nature has done in ages gone by, viz.: distilling petroleum under pressure.

It would require a long time to describe how we solved some of the various problems that arose in connection with this process. From the single 6,000-gallon still we first built, we now have over five hundred stills of a larger capacity. At first our practical men were very loath to accept these pressure stills as a going proposition. They were afraid of them. The minute the slightest thing happened they would be likely to run. But, fortunately, we had no fires or serious accidents for the first two or three years, and when we finally did have a rather bad fire, the men had secured enough self-confidence to stand by their guns, and the damages were repaired quickly and the work went on, so that today the work pressure distillation is carried on in our refineries in connection with the regular routine work, and most of us have forgotten that a few years ago we were met with discouraging protests when we proposed making naphtha products in this manner. During the last five years there have been made in this country over 20,000,000 barrels of gasoline or naphtha products by the use of these stills, and we trust that the future will show a largely increased production (by this process) of this indispensable material.

Future Work for Chemists

Although we know very little about the reactions that occur when petroleum is distilled under pressure, it may be interesting to speculate a little on this subject. Let us start with the paraffin $C_{14}H_{30}$ and see what might happen.

$$C_{14}H_{30} = C_{12}H_{26} + CH_4$$
$$C_{14}H_{30} = C_{12}H_{26} + C_2H_4$$
$$C_{14}H_{30} = C_{14}H_{28} + H_2$$
$$C_{14}H_{30} = C_{12}H_{26} + C_2H_2$$

$$C_{14}H_{30} = 4C_2H_2 + 4CH_4 + C_2H_2 \text{ (All gas)}$$

$$2C_{14}H_{30} = C_6H_{10} + C_{26}H_{52}$$
$$C_{26}H_{52} = C_6H_{10} + C_{12}H_{24}$$
$$C_{12}H_{24} = C_{10}H_{22} + C_2H_2$$

$$2CH_4 + C_2H_2 = C_4H_{10}$$
$$3CH_4 + 2C_2H_2 = C_7H_{16}$$
$$C_2H_2 + 2H_2 = C_2H_6$$

We feel confident that the finished gasoline contains such pariffins as C_6H_{10}, $C_{26}H_{52}$ and $C_{12}H_{26}$, but one of the most interesting results is the formation of free hydrogen as shown in one of the above equations.

The fixed gas formed in pressure still work gives the following analysis:

	Per Cent.
CH_4	56.3
C_2H_6	25.8
Unsaturated hydrocarbons	8.5
CO	.8
H	7.4
Condensible vapor	.6
Undetermined	.6
	100.00

It would seem almost impossible for hydrogen to be set free under the conditions mentioned above, but the analysis of the gas proves this to be a fact. It also seems probable that, under the influence of heat and pressure, the gases of the different series polymerize to form saturated products that are useful.

It is perhaps to be regretted that the chemists engaged in the petroleum industry have contributed so little to the purely scientific side of the subject. Others have done considerable work along this line, but for various reasons, the petroleum chemists have not. The chemistry of petroleum offers a most inviting field for

scientific research, and I trust the time will come when this subject will receive the attention it deserves, and when that time does come, I sincerely hope the chemists who have been trained in the practical work will be in a position to do their bit for the advancement of our knowledge of the chemistry of petroleum.

Shares Tribute with Associates

It would be most unjust and unfair for me to accept at your hands the award of the Willard Gibbs Medal without acknowledging to you the invaluable assistance that I have received from my associates, several of whom I see before me in this room. They are fully entitled to their share in the honor that goes with this medal. Some of these gentlemen are chemists and some, although not having a thorough chemical training, are worthy to be called chemists.

It has fallen to my lot to be the director of the work I have just outlined, but it never could have been brought to a successful termination without the valuable suggestions, indefatigable labor and loyal support of my associates.

Standard Oil Company,
Chicago, Ill.

Activities and Personnel of the Chemical and Explosives Section of the War Industries Board

Leland L. Summers, Chief of Explosives Section
Chas. H. MacDowell, Chief of Chemical Section

Mica	Handled by	J. H. Adams
Acids and heavy chemicals	"	" Albert Brunker, A. E. Wells and R. S. Hubbard
Alkalies and Chlorine	"	" H. G. Carrell
Wood Distillation Products (Acetates and Wood Alcohol), Platinum and Platinum Metals, Commandeering, Requisitioning	"	" C. H. Conner
Toluol Distributions, Creosote	"	" Ira C. Darling
Tanning Materials, Tallows, Greases, Vegetable Oils and Waxes	"	" E. J. Haley
Pigments and Paints	"	" R. S. Hubbard
Coal, Gas Products—Benzol, Toluol, etc., Rare Gases, i. e., Argon, Helium, Nitrogen, Oxygen, etc.	"	" J. M. Morehead
Nitrates	"	" Chas. H. MacDowell
Fine Chemicals (including Medicinal chemicals, Analytical, Photographic)	"	" A. G. Rosengarten
Manganese, Chrome, Tungsten, Ferro-Alloys	"	" H. W. Sanford
Explosives	"	" Leland L. Summers
Glass—Chemical Carboys, Chemical Stoneware	"	" Robt. M. Torrence
Brimstone (Sulphur), Pyrites, Alcohol, Ethyl or Grain	"	" Wm. G. Woolfolk
Inorganic Chemicals, Metallic and Non-Metals, Electrolysis, Electro-Metallurgy, Electric Furnace, Ceramics and Refractories, Organic Compounds and Dyestuffs	"	" Dr. H. R. Moody, Dr. Samuel A. Tucker, Dr. E. R. Weidlein, (Consulting staff)

The Effect of Boiling Sulphur on Copper

By Carle R. Hayward

THE great affinity of sulphur for copper has long been a well-known fact. One of the experiments customarily used in elementary chemistry to show how two elements may be united to form a compound makes use of this affinity. Copper filings and sulphur are mixed together and heated in a test tube, causing the copper to be transformed into a sulphide. When several pounds of sulphide are desired for experimental purposes it is quite natural to mix copper and sulphur in a crucible and heat until fusion takes place, but the sulphide produced by this method usually does not some pure Cu_2S for evperimental purposes and found necessary to break up the mass, add more sulphur and fuse again.

Several years ago the writer had occasion to prepare some pure Cu_2S for experimental purposes and found a modification of the above method more satisfactory.[1]

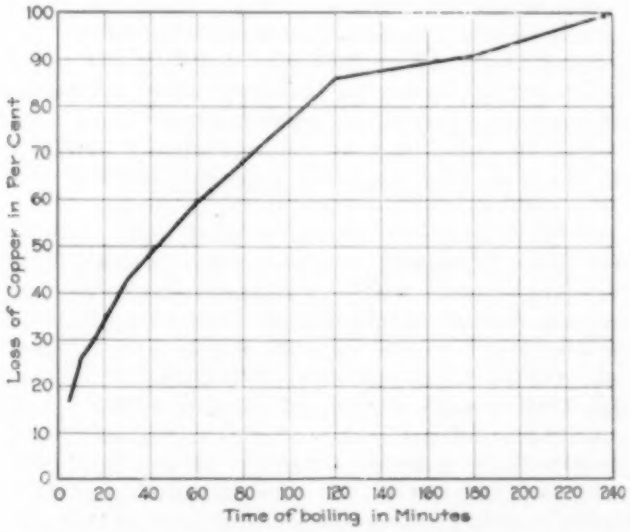

FIG. 1. AVERAGE PERCENTAGE LOSS OF COPPER

Some copper turnings were placed in a large casserole and boiled in sulphur for an hour. On pouring off the sulphur a porous mass remained composed of particles the shape of the original turnings but larger in size. No sign of metallic copper remained. In order to assure complete conversion to Cu_2S, the mass was removed from the casserole, mixed with 15 per cent sulphur and melted in a graphite crucible. After remaining molten for five hours the melt had the composition desired.

An attempt to produce nickel and iron sulphides by this method was unsuccessful. The shavings were practically unattacked by the sulphur.

The boiling of the shavings in the above case was continued for an hour but no attempt was made at the time to ascertain whether an hour was necessary or not. Recently tests have been made to determine the rate of penetration of boiling sulphur into copper and although the results may have no commercial value they bring out several interesting points.

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[1] The Equilibrium Diagram of the System Cu_2S-Ni_3S_2, Trans. A. I. M. E., XLVIII, 141-52.

Rate of Penetration of Sulphur into Copper

The copper used in the experiments was in the form of hard-drawn rods ⅜-inch in diameter. The rod was sawed into ⅝-inch lengths, thus giving a cylinder the length of which was nearly twice as great as the diameter. The specimens were placed separately in iron crucibles containing boiling sulphur which was kept boiling for periods of time varying from five minutes to five hours. At the end of the treatment, the specimen was removed and the adhering sulphur allowed to burn off. The specimen was then weighed, after which it was broken open and the copper core remaining was weighed. The core dropped out when the specimen was broken and the surface was clean. In the specimens where no copper remained, there was a hollow space at the center of the shell. The boiled specimens were in all cases larger than the original and the edges were rounded off. The increase in diameter varied from $\frac{3}{32}$ inch in the five-minute specimen to ¼ inch in the four-hour specimen. The results are given in Table I.

TABLE I. ALL WEIGHTS IN GRAMS

Time Boiled	Weight Before	Weight After	Gain in Wt.	Weight of Core	Loss of Copper	Per Cent. Loss Cu	Loss of Cu Gain in Wt.
5 min.	14.62	15.41	0.79	12.37	2.25	15.4	2.85
5 min.	10.00	10.52	0.52	8.16	1.84	18.4	3.54
5 min.	9.99	10.48	0.49	8.22	1.77	17.7	3.61
10 min.	12.39	13.54	1.15	9.39	3.00	21.7	2.61
10 min.	10.00	10.72	0.72	7.65	3.07	30.7	4.26
10 min.	9.99	10.70	0.71	7.47	2.52	25.2	3.55
15 min.	14.64	15.85	1.21	10.45	4.19	28.6	3.46
15 min.	10.00	10.96	0.96	6.86	3.14	31.4	3.27
15 min.	9.99	10.81	0.82	7.15	2.84	28.4	3.54
30 min.	13.68	15.08	1.40	8.92	4.76	34.8	3.40
30 min.	10.00	11.35	1.35	5.60	4.40	44.0	3.26
30 min.	9.99	11.44	1.45	5.35	4.64	46.4	3.20
30 min.	10.00	11.29	1.29	5.48	4.52	45.2	3.50
1 hr.	9.99	11.86	1.87	3.75	6.24	62.4	3.34
1 hr.	10.00	12.11	2.11	3.00	7.00	70.0	3.31
1 hr.	9.70	11.27	1.57	4.34	5.36	55.3	3.41
1 hr.	9.99	11.63	1.64	4.41	5.58	55.8	3.41
1 hr.	10.00	11.50	1.50	4.87	5.13	51.3	3.43
2 hr.	10.00	12.66	2.66	1.07	8.93	89.3	3.36
2 hr.	10.00	12.36	2.36	1.43	8.57	85.7	3.63
2 hr.	10.00	12.46	2.46	1.72	8.28	82.8	3.36
3 hr.	12.22	15.53	3.31	0.56	11.66	95.5	3.52
3 hr.	9.99	12.77	2.78	0.80	9.19	91.9	3.31
3 hr.	10.00	12.65	2.65	1.16	8.84	88.4	3.33
4 hr.	9.73	12.51	2.88	.....	9.73	100.0	3.38
5 hr.	9.82	12.85	3.03	.....	9.82	100.0	3.24

The average results are given in Table II and the average percentage losses of Cu are plotted in Fig. 1.

TABLE II.

Time Boiled	Gain in Weight of Sample	Loss in Weight of Cu	Per Cent. Loss of Copper	Ratio Av. Loss of Cu / Av. Gain in Wt.
5 min.	0.60	1.95	17.2	3.25
10 min.	0.86	2.86	25.9	3.33
15 min.	1.00	3.39	29.5	3.39
30 min.	1.37	4.58	42.6	3.34
1 hr.	1.74	6.00	59.0	3.44
2 hr.	2.49	8.59	85.9	3.45
3 hr.	2.91	9.90	91.9	3.40
4 hr.	2.88	9.73	100.0	3.38
Average ratio				3.37

The gain in weight can be due only to the taking on of sulphur from the bath and it is fair to assume that this sulphur unites with the copper to form sulphide. It will be noticed, however, that the ratio of Cu to the gain in weight is in every case less than the ratio of Cu to S in Cu_2S which is 3.97. This indicates that the shell produced contains either elemental sulphur mechanically held or a higher compound of Cu and S.

Composition of the Sulphide Shell

In order to determine if possible the exact composition of the sulphide shell, one specimen from each period of boiling was pulverized, washed in CS, and analyzed for Cu. The results are shown in Table III.

It is seen from Table III that there is a slight tendency toward a lower copper content as the time of boiling is increased, but with the exception of the

TABLE III.

Time Boiled	Per Cent. Cu	Time Boiled	Per Cent. Cu
5 min.	78.02	2 hr.	77.24
10 min.	77.50	3 hr.	77.14
15 min.	77.50	4 hr.	77.16
30 min.	77.36		
1 hr.	77.12	Average	77.38

five-minute specimen there is only a difference of 0.38 per cent of copper between the highest and lowest figures so it is possible that the product has in reality the same composition in each case.

The average analysis of the specimens is 77.38 Cu, giving a ratio of Cu to S of 3.42, which is slightly larger than the ratio between the average loss in weight of the copper core and the average gain in weight of the boiled specimen (See Table II).

Several of the specimens were examined under the microscope and revealed traces of CuS near the edge of the section. It seems probable, therefore, that the CuS acts as a carrier of sulphur from the bath to the metal.

The formula which most nearly corresponds to the composition of the material obtained is $5Cu_2S.2CuS$, which contains 77.31 per cent copper.

The results may prove of interest to the geologist in studying the formation of covelite and chalcocite or may have a bearing on the phenomena in kernel roasting.

Massachusetts Institute of Technology,
Cambridge, Mass.

Mining Engineers Drop Enemy Aliens

At a meeting of the Board of Directors of the American Institute of Mining Engineers held Wednesday evening, May 29, important resolutions were passed affecting enemy alien members of the Institute. The first resolutions proposed were modified to more nearly meet the approval of the directors present and the following were finally adopted after considerable discussion during which strong views were presented both for and against the proposal. In their final form these resolutions will scarcely find objectors among Institute members:

"Resolved, That all honorary members, members, associate, and junior members who are enemy aliens, residing in enemy countries, be dropped from membership in the American Institute of Mining Engineers, and their names be, and they are, stricken from the rolls.

"Resolved, That the Membership Committee be requested to advise this Board of Directors of the names of all the above mentioned persons, and in addition the names of all other enemy aliens, members of the Institute, and be it further

"Resolved, That, in the case of said latter class, this Board shall consider and act upon the question of expulsion after ascertaining their attitude toward the Government of the United States."

The action of the Board of Directors will affect immediately 21 Germans and 1 Austrian who held either honorary or active membership in the Association. A thorough census will be taken of all other enemy alien members with a view to ascertaining their loyalty to the United States.

Synopsis of Recent Metallurgical and Chemical Literature

Viscosity of Blast-Furnace Slags.—Very important work from a theoretical and practical standpoint on the viscosity of iron blast furnace slags has been completed at the Pittsburgh station of the Bureau of Mines by A. L. FEILD and associates. A description of the problem and methods of solution was published by Mr. Feild in the *Transactions* of the Faraday Society, 1917, Vol. 13, part I, while recent *Bulletins* of the American Institute of Mining Engineers contain abstracts of Bureau of Mines *Technical Paper* No. 189, containing a record of the scientific data obtained, and of Bureau of Mines *Technical Paper* No. 187 on "Slag Viscosity Tables for Blast Furnace Work."

Silicates in general pass from a solid to a mobile liquid by a series of imperceptible steps. Lacking the characteristic of the sharp melting points of a pure compound, many determinations of the "softening" temperature have been made, wherein the deformation of a cone-shaped sample was observed. This "softening" temperature, according to Mellor, is that temperature where the inward surface pressure overcomes those intermolecular forces preventing an orientation conforming to the minimum surface of stable equilibrium. The softening of cones is therefore the resultant of the viscosity decrease, the action of surface forces, and the action of gravity. In general, the softening of silicates depends upon the amount of eutectic present; if a large amount of fusible eutectic is contained in the solid, softening may easily occur at a low temperature even when the viscosity of the fused portion is high.

The studies in viscosity described in these papers were made in a modified Margules apparatus (See METALLURGICAL AND CHEMICAL ENGINEERING, Vol. 15, page 541). The powdered slags were placed in a crucible made of 1¼-inch round graphite electrode, bored ¾ inch (diameter = b) 3 inches deep, and heated in an improved "gran-annular" furnace. This furnace was surrounded with a tight iron casing, and an atmosphere of CO+N maintained. Into the slag was immersed a ½-inch (diameter = a) graphite cylinder, hung from a balanced astatic spring-suspension. On being rotated slowly at an angular velocity w the viscosity of the slag caused a measured couple c in the inner cylinder suspension which is related to the viscosity n as follows:

$$C = 4\pi n L \frac{a^2 b^2}{b^2 - a^2} w$$

where L is the common length of the two cylinders, disregarding end effect. Viscosity determinations were thus made at intervals during a regular heating and cooling cycle, the upper limit being the temperature resisted by the lundum furnace cores, and the lower the strength of the inner-cylinder suspension. Thirty-six viscosity tables are given in *Technical Paper* 187 covering all commercial iron blast furnace slags figured on the basis of $CaO+SiO_2+Al_2O_3 = 100\%$, covering each even per cent of alumina from 7 to 24, and their use explained by reference to specific problems in blast furnace practice.

The determined data indicate that the compounds which are stable in solid slags, (for instance: gehlenite and calcium metasilicate), do not decompose thermally into their constituent oxides on melting, for the following reason: The temperature-viscosity curve of the slag represented by Rankin and Wright's quintuple point 2 (see *American Journal of Science*, Vol. 39, page 1), was determined over a viscosity range from 100 to 2000 and yielded an equation between temperature T and fluidity f (fluidity is the reciprocal of viscosity) as follows, correct to plus or minus 5.5 deg. C.

$$T = 1167 + 7.37\ f - 4.45\ f^2$$

if this equation may be extrapolated from $f = .0005$ to $f \div 0$, it shows that 1167 deg. C. is the temperature where viscosity becomes infinite, which, by the way, is Maxwell's criterion of the solid state. Rankin and Wright determine the melting point at 1170 deg. C. plus or minus 5, by noting the change in optical properties from the crystalline to the amorphous state. If therefore, the melting point of a mixture of compounds can be thus predicted from the behavior in the fluid state, the compounds certainly do not dissociate immediately or discontinuously on melting.

Such considerations affect the conceptions of slag action such as desulphurization. At slag forming temperature the sulphur (mostly introduced as coke ash) is almost entirely in the iron. The reaction generally given to cover its transfer to the slag is

$$FeS\ CaO \rightleftharpoons CaS + FeO$$

with the following side reaction

$$FeO + C \rightleftharpoons CO + Fe$$

the two ordinarily combined as

$$FeS + CaO + C \rightleftharpoons CO + Fe + CaS$$

This latter reaction is now seen to depend upon the hypothetical thermal dissociation

$$Ca_2Al_2SiO_7 \rightleftharpoons CaSiO_3 + CaAl_2O_4$$
$$CaSiO_3 \rightleftharpoons CaO + SiO_2$$
$$CaAl_2O_4 \rightleftharpoons CaO + Al_2O_3$$

The final distribution of sulphur therefore depends upon the equilibrium constants of the last four equations. Disulphurization cannot simply be expressed in terms of the per cent of CaO in the slag, nor even worked out from Nernst's distribution law and the law of mass action if applied to the uppermost reaction only.

The reactions of desulphurization take place at the iron: slag interface, and the CaS formed there must diffuse into the slag at a speed high enough so that the reaction may continue until it reaches an approximation of the equilibrium ratio between sulphur in the iron and slag in the limited time available. A high hearth temperature which will promote fluidity and thermal dissociation of a properly constituted slag will promote desulphurization, provided the slag viscosity is not so low as to release its trapped iron globules too quickly. The reduction of silicon never approaches equilibrium, and the amount of silicon in the metal is therefore independent of the slag viscosity, *per se*. Consequently, high temperature, long contact, or both, favors a high silicon, low sulphur foundry iron. A moderate temperature and moderate time in contact produces low silicon and moderate sulphur, as does also a high temperature and short time of contact. These conditions are present in the furnace when making basic

iron, either with a very basic slag and a light burden, or with a somewhat basic slag and a heavy burden.

Since the composition of a blast furnace slag determines the rate of change of the temperature-viscosity curve, it determines the temperature of the smelting zone at a given rate of driving, and the length of time the iron is in intimate contact with the slag. The intelligent use of such relations would therefore reduce the losses in off-grade pig, improve fuel economy, promote operating efficiency, and extend present practice to cover lean and complex ores. Furthermore, since the radius of iron globules in contact with the slag approximates a constant quantity under operating conditions, the loss of metallic iron in slag should be directly proportional to the viscosity of the slag at the hearth temperature and to the rate of pig production.

Physical Constants of Ammonia.—NATHAN S. OSBORNE and M. S. VAN DUSEN have given the results of recent researches on the physical constants of ammonia in Bureau of Standards *Scientific Papers* Nos. 313, 314, and 315. The specific heat of saturated liquid ammonia was determined by two independent methods, using calorimeters specially adapted for the work, and an empirical equation devised which expresses the experimental results to within one part per thousand. The specific heat σ in joules per gram per degree centigrade, of liquid ammonia, kept saturated, at the temperature θ, is given in the range —45° to + 45° C, by the equation

$$\sigma = 3.1365 - 0.00057\theta + \frac{16.842}{\sqrt{133 - \theta}}$$

The latent heat of vaporization was also determined and the following equation derived with the same degree of accuracy: The latent heat of vaporization of ammonia, that is, the heat required to convert saturated liquid into saturated vapor at constant temperature, in joules per gram, is expressed for the range -42 to -52 deg. C. by the equation:

$$L = 137.91 \sqrt{133 - \theta} - 2.466\ (133 - \theta)$$

If the latent heat of vaporization is expressed in calories$_{20}$ per gram, taking 1 calorie$_{20}$ = 4.183 joules, the equation becomes

$$L = 32.968 \sqrt{133 - \theta} - 0.5895\ (133 - \theta)$$

The transformation of energy into heat or vice versa, resulting from a change in pressure in liquid ammonia has also been determined by three independent methods, and tabulations for the range — 40 to × 40 deg. C. are presented.

Fine Grinding at Inspiration, Miami, and Anaconda.—Criticizing Mr. C. T. Van Winkle's paper on "Recent Tests of Ball Mill Crushing", E. H. KENNARD, who conducted the Inspiration tests for Mr. Hardinge, called attention to the close and expert attention necessary for a ball mill and ascribes the excellent performance of the Marcy mill to the experience in its handling gained by the operators in two years' practice, and the poorer production of the Hardinge type to improper location and defective arrangements for handling the pulp. The table of relative performance is also claimed to be misleading in that it is merely the record of a single day's run.

A. E. WIGGIN, superintendent of concentration for the Anaconda Copper Mining Company, said that previous to remodeling the Washoe concentrator a Hardinge pebble mill of 10-ft. diameter and 4-ft. cylinder was tested in comparison with an 8- x 12-ft. Power and Mining Machinery Co. tube mill, using pebbles and having a trunnion discharge. The results showed the Hardinge mill to be slightly superior, but he always considered the trunnion-discharge tube-mill and the Hardinge mill to be on a par as regards efficiency and costs of fine crushing. As they were obliged to order mills to remodel the entire concentrator without waiting the results of any more testing, and as they had experienced much mechanical difficulty and delay in deliveries with the tube-mill, it was decided to order Hardinge mills, and they saw no good reason for ordering any other size than the one they had tested. Since they had few data as to the relative merits of iron-ball vs. pebble crushing, they figured tentatively that while for pebble-crushing eight 10- x 4-ft. mills using 150 horsepower each would be required per section, for ball-crushing the same amount of material it would require four or five mills lagged down to 8 ft. in diameter, and using considerable more power. A compromise of 6 mills and 225-horsepower motors was finally agreed upon. Changing the shape of the mill did not, in any way that they have been able to detect, increase the efficiency of the Hardinge mill. The one factor which was responsible for the great improvement in their crushing efficiency is the reduction in the speed of the mills. When these were converted into iron-ball mills, 7½ x 6 ft. in size, the speed was first maintained at the original 23 r.p.m. Tests were later made at lower speeds, and at the conclusion 15 r.p.m. was fixed as the most efficient speed for these mills. This diminished the power consumption from 215 to 140 horsepower per mill, or a total of 2250 horsepower, and the ball consumption from 4.5 to 3.25 lb. per ton crushed, totalling 13,500 lb. per day, and, of course a considerable saving in lining and general repairs. The tonnage crushed and the fineness of the crushing are unaffected, and the savings from the two items mentioned amounted to over $250,000 per year.

Tests of American and Foreign Chemical Glassware

Prior to the summer of 1914 the greater part of the chemical laboratory glassware used in this country was imported from Germany and Austria. The cutting off of imports from these countries caused a very serious shortage of glassware in this country, which is not yet entirely overcome. However, within the past two years a number of American manufacturers have increased their production of such ware.

In order to furnish to chemists information regarding such domestic brands, it was decided by the United States Bureau of Standards to compare them with those of foreign make. These results of the bureau's tests indicate that all of the American-made wares tested are superior to Kavalier and equal or superior to Jena ware for general chemical laboratory use. Results of these tests are given in Technologic Paper, No. 107, "Comparative Tests of Chemical Glassware," which may be obtained from the Superintendent of Documents, Government Printing Office, for 10 cents.

Recent Metallurgical and Chemical Patents

Continuous Zinc Smelter.—A continuous zinc smelter has been patented by WOOLSEY MCA. JOHNSON, of Hartford, Conn., illustrated in Fig. 1, and consisting essentially of a continuous complex retort heated at the receiving end by ordinary fuel, and by electricity at the fusion end, provision being made for the recovery of various products according to the temperature of their evolution. Pre-roasted ore, containing more than the usual amount of sulphur left in zinc ore designed for retort smelting, is mixed with a suitable amount of coal, preferably of a sort involving enough volatiles to create a draft in the pre-heating operations, and the mixture is introduced into the proper hearth 5. The ore is rabbled from each hearth to the next lower, and continuously subjected to a temperature of about 1050 deg. C., which is maintained by the conduction of heat through the retort walls from hot furnace gases circulating from the fireplace A through the passageways enveloping the pre-heating hearths. During this passage considerable sponge iron is formed, practically all the cadmium is evolved, and the ore is finally fed into the electric smelting furnace continuously through the downtake 30. Here the charge is smelted at a high temperature, the liquid portion being tapped at intervals and separated into metallic iron, molten matte, and a slag, while the zinc is volatilized, led into the condenser 43 and eventually drawn off and cast into bars from spout 45. (1,244.504, Oct. 30, 1917.)

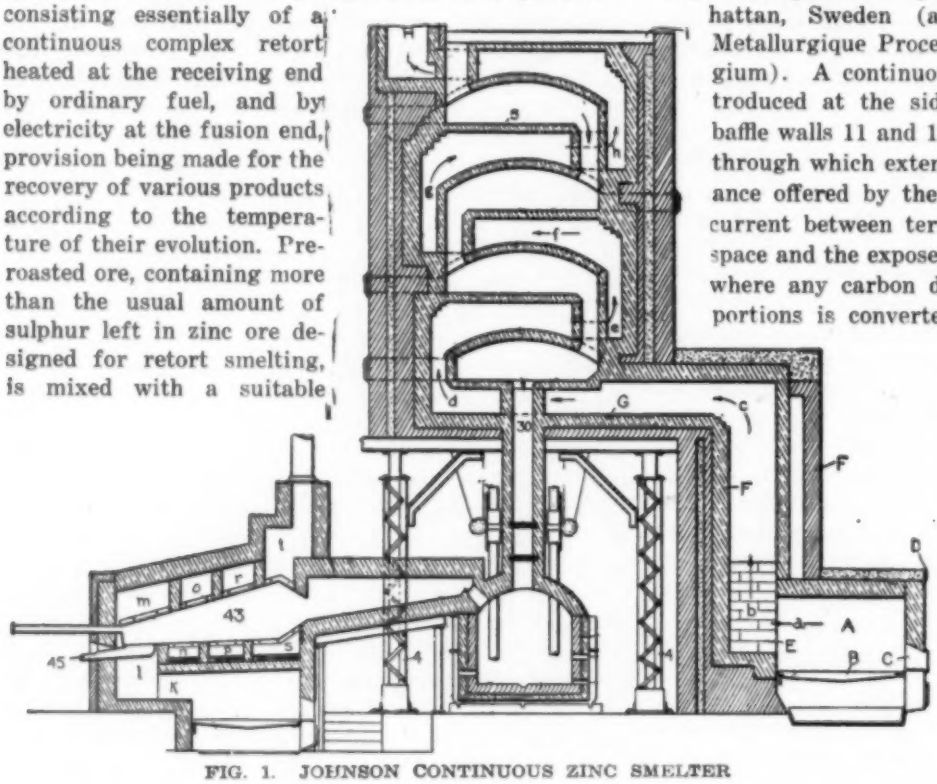


FIG. 1. JOHNSON CONTINUOUS ZINC SMELTER

Electric Furnaces for Zinc Reduction.—The method of extracting zinc from ores illustrated by means of Fig. 2 is patented by E. A. JOHANSSON, of Trollhattan, Sweden (assigned to Société Anonyme Metallurgique Procedes de Laval, of Brussels, Belgium). A continuous supply of cold charge is introduced at the sides of the furnace behind the baffle walls 11 and 12, which enclose a vacant space through which extends the electrode 2. The resistance offered by the charge to the passage of the current between terminals heats the entire vacant space and the exposed surface of the heap to a point where any carbon dioxide generated in the cooler portions is converted to monoxide on passing out through the heated surface. (1,256,802, Feb. 19, 1913.)

FILIP THARALDSEN, of Christiania, Norway, observes that in smelting any heap of ore as mentioned in the preceding, the reduction and melting does not take place evenly over the surface of the heap as intended, but the localized action of the arc will eat cavities into the charge, the walls of which will eventually collapse, with the formation of quantities of undesirable dust. He therefore proposes the furnace sketched in Fig. 3, where a heap of ore charged into auxiliary chamber *b* at the left is struck out into a flat sheet by the movement of the car-body-hearth, and this flat sheet of ore smelted by radiation from a bare arc in the central chamber *a*. As the movement of the car proceeds to the right, the smelted residue is removed by the rake *k* as it enters chamber *b*. As the first charge is exhausted, a new portion of ore is dropped into the right hand chamber *b*, the movement of the hearth reversed, and the process continued as before. (1,255,066, Jan. 29, 1918.)

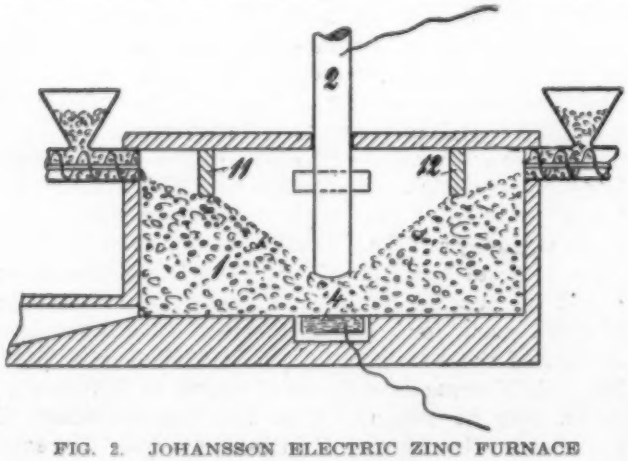


FIG. 2. JOHANSSON ELECTRIC ZINC FURNACE

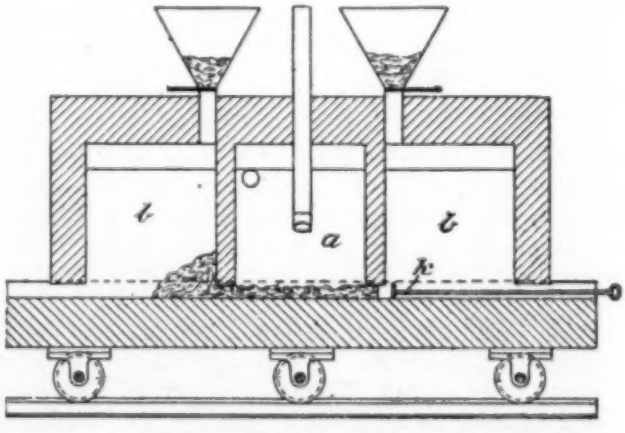
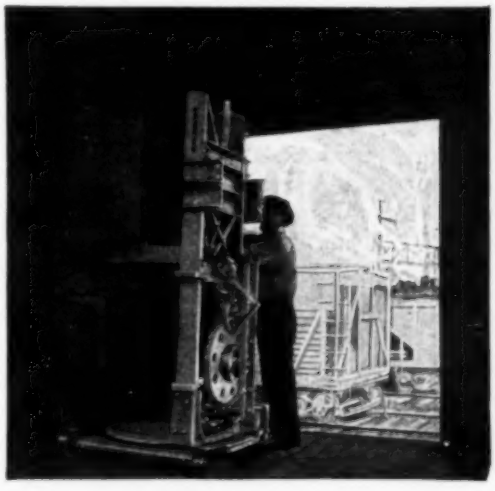


FIG. 3. THARALDSEN ELECTRIC ZINC FURNACE

Tiering in Freight Cars

TO UTILIZE all the storage space in freight cars is now a Government necessity and the piling of material that is required. At the same time, labor is so scarce



MACHINE FOR TIERING GOODS IN FREIGHT CARS

that concerns shipping heavy goods, such as rolls of paper, cases, bales, crated machinery, etc., are having difficulty in getting this work done. For this purpose the Revolvator Co., of Jersey City, N. J., has developed a portable tiering machine. By means of this machine one or two men can pile the goods clear to the roof of the car. The illustration shows one man tiering a 1000 lb. bale of waste inside a freight car. Without the machine, at least four men would be required.

New Design of Sextuple Effect Evaporator

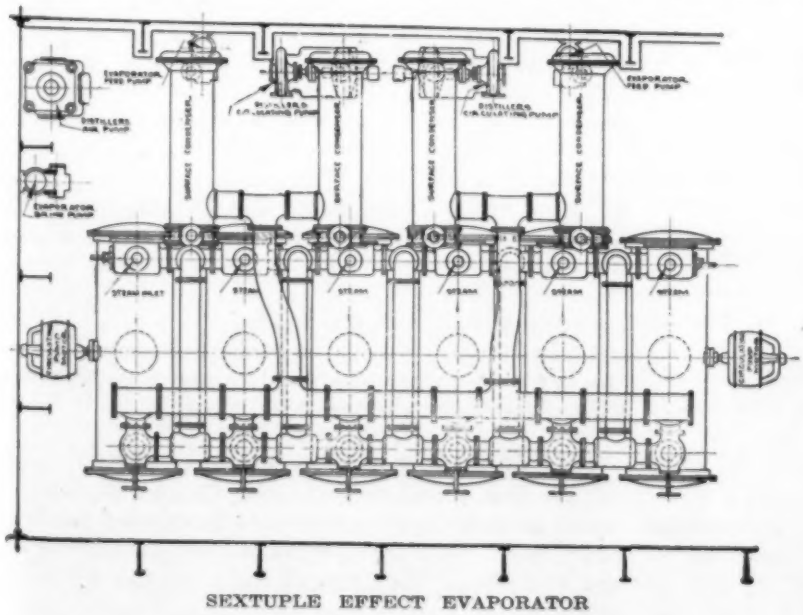
THOSE who have to deal with the distilling of sea or other water or with evaporation problems in general kind, will be interested in a design of Lillie evaporator now being built by the Wheeler Condenser & Engineering Co., of Carteret, N. J. It is a modification of a regular Lillie sextuple effect sea-water distilling apparatus. Two of these now under construction are to be operated by steam up to 60 lb. per sq.in. gauge pressure, or at any lower pressure.

Four condensers, side by side, are employed as shown in the illustration.

This arrangement of condensers permits seven different combinations of operation, as follows:

1. It may be operated as one single effect or more single effects;
2. It may be operated as one or more double effects, with vapors reversible in each;
3. It is possible to operate it as a triple effect, or as two triple effects, with vapors reversible in each;
4. It is impossible to operate it as two quardruple effects, but every effect may be utilized by grouping as one quadruple effect and one double effect, in both of which the vapors are reversible;
5. It may be operated as one vapor reversible quadruple effect with both and effects or either end pair of the section cut out;
6. With one effect at either end cut out, it may be operated as a vapor reversible quintuple effect.
7. Lastly, it may be operated as a vapor reversible sextuple effect.

It is evident that should a mishap occur at either end, in the middle, or anywhere else, there is little danger that this evaporator will be put out of commission entirely.



SEXTUPLE EFFECT EVAPORATOR

Enemy Piracy of Trade Marks

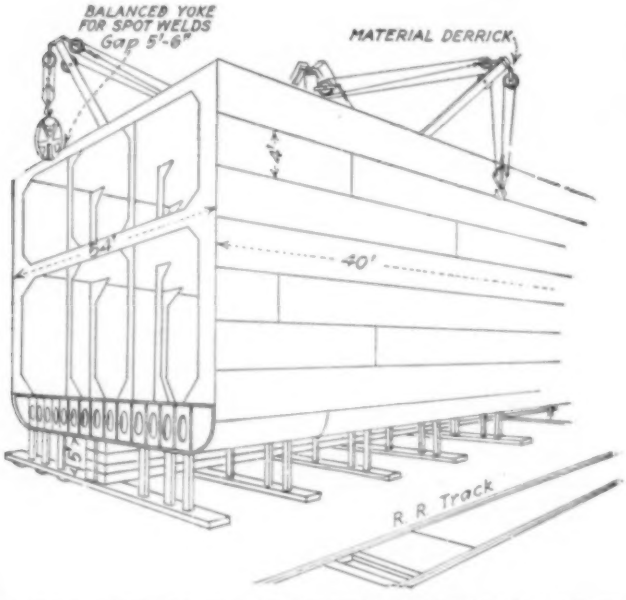
Our attention has been directed by Dr. L. H. Bakeland of the Naval Consulting Board to a new form of enemy piracy relating to trade marks of American manufacturers. Certain countries recognize the first to register a trade mark as the rightful owner and hold that the subject is not open to further discussion. Argentina, Brazil and Chile are among those in which the rule prevails.

There is also a Trade Mark Convention among the following countries with headquarters at Berne: Austria, Belgium, Brazil, Cuba, Spain, France, Hungary, Italy, Mexico, Holland, Portugal, Switzerland and Tunis. On payment of a fee of 100 francs to the central bureau by any member of the Convention, the ownership of a trademark is registered in all 13 countries. Austrian firms have been active in this respect and as an example, Mr. Richard Mittler of 6 Wiesingerstrasse, Vienna, has registered as his, Ajax, Federal, Firestone, Fisk and Republic automobile tires, unless the actual owners were there before him. Additional instances are known of the registration by a German, formerly resident in Belgium, of the names of three well-known American typewriters, of Jap Rose Soap, Foos Gas Engines and the Waukegan mark of the American Steel and Wire Co.

The State Department has the matter in hand. American manufacturers are urged to register their trademarks in other than enemy countries without delay.

Test of Electric Welding for Steel Ships

THE purposes and possible benefits of the ship welding test now being conducted at the Federal Shipbuilding Company plant at Newark, N. J., are outlined in a report by Arthur J. Mason, vice-president of the corporation. We quote in part from the report as follows: Electric welding in its various phases has



PART OF SHIP'S HULL THE PLATES OF WHICH ARE BEING JOINED PARTLY BY RIVETING AND PARTLY BY WELDING

for years been employed in shipyards and in the arts generally, but for a number of reasons the work has been confined to odd jobs and repairs. The proposal to extend its use to the major part of ship construction has met with gratifying approval from the shipbuilder. It remains for us through this large test to demonstrate its economy in time and money and its adequacy to build a stanch ship.

The purpose of this test is to demonstrate these advantages—to do it in such a way that all may see and contribute, and finally to test the structure itself so completely that there will follow a heart-whole and unanimous belief in the method.

The test itself will take the form of building part of a hull at the Federal Shipbuilding Company's plant, Newark, N. J.

A 10,000-ton ship, costing $2,000,000, now costs but $70,000 to rivet. It must be plain that if electric welding only promises to modify this amount no very substantial gain offers.

Splendid benefits we all feel do offer themselves in the possible change in the whole regime of shipbuilding. Our test has in view abolishing, or greatly diminishing:

1. The railroad journey from rolling mill to fabricating plant, when the latter is not at the shipyard.
2. The templet makers' work.
3. The makers' work.
4. The punching.
5. Much of the work of fitters and bolters who flog and pull the pieces to fit on the ways. There lies in the above items an excellent likelihood to save a month's time in construction and a saving of no less than $40 a ton in the cost of steel structure, at least $100,000 a hull on a 10,000-ton vessel.

Briefly the program is to assemble a hull rapidly by spot welding, tacking the ship together much as a tailor bastes his work in assembling a suit of clothes. The structure then becomes a house favorable for work in all weather and at night in which the completion of the ship may go on.

After the material is thus assembled and fastened with spot welds, so that it is sufficiently strong to hold its shape, the work is completed by arc welding all seams to insure strength and render the work watertight. Roughly we expect the spot welds to be about 10 in. (25.4 cm.) apart.

One-quarter of the structure will be riveted, the other three-fourths welded, so that the tests of strength will afford a basis of comparison.

Electric welding offers a great field for lightening a ship. In this design various views of this opportunity will be tried out. The field here is very great —ultimately 10 per cent of the steel may be eliminated.

One derrick will bring material, the other derrick support the spot-welding yoke, whose function is to tack the material together, fastening the plates either to the frames or to the adjoining plates.

The problems of fitting in place the parts of a hull are almost wholly problems arising out of the necessity to make a number of little holes in a plate made by one man at one time and place fit a number of little holes made by another man at another time and another place.

Once all holes are left out of the material, all parts fit. The creeping and kindred problems so perplexing to the shipbuilder disappear. Every plate becomes a closer. Every plate justifies itself.

The manufacture of the spot-welding yoke and appliances is placed in the hands of the Universal Electric Welding Company of Long Island City. The design of the yoke is completed, the patterns are made and steel castings will be forthcoming in the next ten days. The early stages of the arc welding are to be accomplished by the Wilson Electric Company, which was so successful in the work on the German ships' repairs, but it is the intention to call in all men with ideas and apparatus and to give them a field to test out in actual work. To this end Professor Adams' committee is searching out all available talent.

An adequate system of testing the work when done is under consideration. The primary test will consist of filling the hull with water and shifting the points of support under continual and close scrutiny, as one-quarter of the whole will be riveted in the normal manner. There will be always a gage of comparison with that portion which is welded.

Likewise there will be a chance for comparison of the two forms when subjected to abuse by bumping with rams and in various other ways.

Lord Reading, British Ambassador, while inspecting the Hog Island shipyard with Charles M. Schwab, where an 8500-ton freighter is to be finished every 48 hours, said: "Give us ships like this and we will win the war even should the Germans reach the Channel Ports or Paris."

Book Reviews

METHODS FOR TECHNICAL SAMPLING AND ANALYSIS OF GASES. Copyright 1918 by *J. M. Camp*, Chairman Chemists' Committee, United States Steel Corporation, Pittsburgh.

This revised second edition of the pamphlet on gas analysis has been prepared by a committee of chemists from several of the plants of the U. S. Steel Corporation. Like the first edition it is an example of the technical benefits resulting from bringing into one large organization a number of separate units with their combined experience and knowledge. It is doubtful whether a better set of technical methods of gas analysis could be compiled.

This is very similar to the first edition (reprinted in METALLURGICAL AND CHEMICAL ENGINEERING, Vol. IX, pp. 302 and 356). Additions have been made to the text in the way of a method for the analysis of by-product gas, as nearly as possible like that already published for producer and blast-furnace gases, with methods for the determination of its content of benzol, total sulphur, and cyanogen. A method for the analysis of natural gas has been incorporated that differs slightly from that given for other fuel gases in that larger quantities for explosion are employed. This feature of the method is of decided advantage, because no error is introduced by a high percentage of resulting carbon dioxide. Elementary calculations of thermal values, specific gravity, and air necessary for combustion are explained and illustrated.

This series of pamphlets, which also includes publications on the sampling and analysis of iron ore, pig iron, steels and coal, coke and by-products, forms a most valuable critical compilation of useful methods based on extended research and wide experience.

* * *

POWDERED COAL AS A FUEL. By *C. F. Herington.* 211 pages, price $3.00 net. New York, D. Van Nostrand Co.

The author collected the material for this book while asistant engineer of the New York Central Railroad Co. The historical notices consist largely of patent abstracts, the descriptions of machinery seem to be taken from manufacturers catalogues, while the chapters relating to the application of powdered coal to various industries are lifted largely from published literature. For instance, Chapter VI, on the application of powdered coal to reverberatory furnaces consists of the two papers by David H. Browne of the International Nickel Co. and Louis V. Bender of the Anaconda Copper Mining Co., presented before the February, 1915, meeting of the American Institute of Mining Engineers. Even the well illustrated chapter on powdered coal for locomotives, where the author presumably has had experience and could speak with authority, is apparently an abstract of J. E. Muhlfeld's paper before the December, 1916, meeting of the American Society of Mechanical Engineers. Elsewhere H. Barnhurst's papers before the Mining Engineers and in this journal, and A. S. Mann's experiments published in the General Electric Review are also quoted very extensively. A bibliography compiled by the Engineering Societies' Library is uncollected as to author, publication, date, subject matter and lauguage.

In the introductory part the author presents estimates of the cost of construction and operation of various comparable systems, showing a great advantage accruing to the Holbeck system. In this the coal is transferred in suspension in air in a closed circuit from the storage bin, through the furnace rooms, and back again, returning the unburned fuel to the starting point. Mr. Herington notes that the most recent developments have been made in utilizing very low grade fuels, such as anthracite culm, and that the amount of ash in the combustible, up to 33 per cent, is not of as great importance in most practices as is whether it produces a "soft" undesirable clinker, or a "hard" brittle clinker giving a light, fluffy ash and little trouble.

The book collects a considerable amount of information as to the proper separation of air from the coal after pulverizing, and as to the proper mixing of air and coal before and during burning. As to the many designs of burners which have been introduced or patented, he quotes the words, "Any mechanism which will give a uniform mixture of coal and air with both under control can be used as a burner for powdered coal."

* * *

METALLURGICAL CALCULATIONS. By *Joseph W. Richards.* One Volume edition, octavo, xxiii + 675 pages. Price $5.00. New York: McGraw-Hill Book Company, Inc. London: Hill Publishing Co., Ltd.

Many users of Dr. Richard's "Calculations" will be pleased to know that a one-volume edition has been issued. Part I, as incorporated herein, has been considerably revised and brought up to date. The separate parts are still obtainable, for the use of students and technologists.

Published originally as a serial in Metallurgical and Chemical Engineering, this treatise on quantitative metallurgy has earned for itself an international reputation; it has in numberless cases pointed the way to a deeper understanding of metallurgical processes and to higher metallurgical efficiency. It has struck the keynote of metallurgical progress in the Twentieth Century.

* * *

STEEL AND ITS HEAT TREATMENT. By *Dennison K. Bullens*, Consulting Metallurgist. Octavo, 483 pages, 285 illustrations; price, $4.00 net. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd.

This is a second edition of an excellent treatise reviewed in our issue of July 15, 1916. That the book has met with a wide demand is evidenced by the early exhaustion of the first and second impression. In the third printing, the author has availed himself of the opportunity of a thorough-going revision of the text, enabling him to correct many of the errors of omission and commission noted in our earlier review.

Mr. Bullens is to be highly commended for introducing a great deal of matter in his new edition regarding the influence of the human element in heat treatment. He calls attention to the fact that the heat treater is the chef that puts the metallurgical finish on material prepared at great expense by others, and it is his skill and exercise of judgment that determines the final result which either makes or breaks the operation. In many cases the installation of pyrometric equipment merely results that the operator in effect is doing nothing more than manufacturing record charts, instead of properly heating his steel. Good steel is entitled to proper treatment in good furnaces, and both are entitled to the services of good men to produce good results; the best men available are none to good for such important work. Not only is this true, but the strongest language that could be employed to describe the general average heat-treatment equipment, the methods of heating and personnel as they are actually known to exist, would be altogether too mild and ineffective for a proper description of the heating methods and equipment in the majority of forge shops in the country. The apparent advantages of the motor truck were not side-tracked by the fact that it was necessary to teach men how to operate them, and yet there is just as much if not more reason why men, and if necessary a different type of man, should not be taught how properly to heat steel.

* * *

DISEASES OF OCCUPATION AND VOCATIONAL HYGIENE. Edited by *Geo. M. Kober*, M. D., LL. D., and *Wm. C. Hanson*, M. D., aided by 29 Specialists. Octavo (23 x 15 cm.), xxi + 918 pages, 46 illustrations. Price $8.00. Philadelphia: P. Blackiston's Son & Co.

It would be difficult to praise this book too highly. It is written not only to describe Specific and Systemic Diseases of Occupation to medical and legal experts, medical examiners, insurance examiners, practising physicians, teachers, lawyers, students, but also to treat of the Causation and Prevention of such diseases, for the benefit of employers,

employees, public health officials, nurses, social workers, legislators and teachers. The editors themselves wrote most of the chapters on Causation and Prevention, and they are most excellently written. Twenty-two pages on the iron and steel industries, twenty-four on mining and quarrying, seventeen on food industries, thirteen on brass, copper and zinc industries, are examples of the thoroughness of the treatment. The chapters on history, legislation, statistics, etc., are very well written. The book should be found in every industrial plant, and should be well-studied and its teachings closely followed.

Personal

Mr. JULIUS ALSBERG announces the opening of his metallurgical and chemical engineering consulting offices in the Tribune Building, Chicago.

Mr. D. W. BRUNTON of Colorado has been elected a member of the Naval Consulting Board.

Mr. P. B. CHILLAS, Jr., formerly in the Research Laboratory of the National Carbon Co., Inc., is now at the Frankford plant of the Barrett Company, Philadelphia.

ENGINEERING FOUNDATION BOARD has elected the following to membership: Mr. CALVERT TOWNLEY, Westinghouse Electric Mfg. Co.; Mr. SILAS H. WOODWARD, M. Am. Soc.; Dr. JOSEPH W. RICHARDS, Lehigh Metallurgy Dept.; Dr. DAVID S. JACOBUS, Babcock & Wilcox; Mr. H. HOBARD PORTER, Sanderson & Power.

Mr. WOOLSEY MCA. JOHNSON married Miss KATHRYN VERONICA O'HARA, daughter of Mr. and Mrs. W. S. O'HARA of Philadelphia. The couple are now at Washington but later will reside at Cynwyd, Pa.

KENNETH DESPRES KAHN, research metallurgist of Cleveland Brass Manufacturing Co., Cleveland, O., is assistant chemical engineer, division of small scale manufacturing of war chemicals, American University, Experiment Station, Bureau of Mines, Washington, D. C.

Mr. A. LINCOLN KONWISER, formerly superintendent of the Hygiene Chem. Co. at Elizabethport, N. J., and until recently connected with the chrome plant of the Metals and Thermit Corporation, has been appointed factory superintendent and chemical engineer for J. S. & W. R. Eakins, Inc., Brooklyn, N. Y.

Mr. WM. R. LAFFERTY, formerly chemist at the Camden and Bayonne Works of the General Chemical Co., has recently become assistant superintendent at the Bridesburgh, Pa., factory of Charles Lenning & Co.

Mr. WM. A. LEWIS has closed his plant at Monroe and Ferry Sts., Hoboken, N. J., having enlisted in the U. S. Naval Reserves.

FRANK K. MARVIN, formerly Chief Chemist of the Howard Smokeless Powder Co. plant and Aetna Research Laboratory at Emporium, Penn., has been appointed explosives chemist of the Bureau of Mines and stationed at Pittsburgh, Pa.

Mr. E. P. MATHEWSON, who has been with the Anaconda Copper Co., then the British American Nickel Corporation, recently returned to the American Smelting & Refining Co. as consulting metallurgist. He will be at the New York office of the latter company.

Mr. FREDERICK J. MAYWALD has shifted his office and laboratory so that the other entrance of the building at 133 Water Street must be used when entering to consult him.

Mr. JAMES H. READIO, JR., has left the Pawtucket Gas Works to become assistant chemical engineer with the Providence Gas Co.

Prof. G. A. ROUSH of Lehigh University has been appointed supervisor of training, Inspection Division, Ordnance Department. He will have charge of the training of inspectors, recently inaugurated by the War Department.

Mr. FOREST RUTHERFORD, consulting metallurgist, New York City, has been appointed a member of the advisory committee in non-ferrous metals to the U. S. Tariff Commission.

Mr. A. GORDON SPENCER, consulting chemist and metallurgist, Montreal, P. Q., has given up his practice to devote all his time to metallurgical work for Peter Lyall & Sons Construction Co., manufacturers of munitions.

Mr. ROGER TAYLOR has been assigned to the Ordnance Reserve Corps and has therefore severed his connection with the engineering firm of Frederick deP. Hone & Co., New York.

Mr. JOEL H. WATKINS, formerly economic geologist for the Southern Railway, has opened consulting offices at 200 Fifth Avenue, New York, where he will give special attention to the mineral resources of the Appalachian region.

Mr. A. E. WIGGIN has been appointed general superintendent of the Boston & Montana reduction department of the Anaconda Copper Mining Co.

Current Market Reports

Non-Ferrous Metal Market

Friday, June 7.—Prices are tending to be better controlled by the Government. Copper and manganese prices are fixed by law; lead is advancing; tin has fluctuated due to abnormal shipping.

Aluminium.—Government advanced the rate to 33c.

Antimony.—The Government was in the market for 250 tons for July. We quote spot at 12¼ @ 12⅜c. futures at 11¼c. c.i.f. in bond.

Chrome.—Producers have established a schedule on the basis of $1.30 per unit ore.

Copper.—War industries board set prices at 23½c. until Aug. 15. Producers' meeting called for Aug. 7.

Lead.—There are widespread inquiries and negotiations for future deliveries, the disposition being to stock up. Prices have advanced to 7⅜c.

Manganese.—Price scale with silica and phosphorus penalties. Unit prices: 40 per cent $1.10, 50 per cent $1.20. See further report.

Molybdenum.—Quoted at $1.25 per lb. of 90 per cent molybdenum sulphide.

Smelter.—Market was stronger; business very light. Quoted at 7¼c. to 7½c.

Tin.—Varying prices. Chinese tin at San Francisco, 86c.; Straits tin, New York, $1.08 to $1.10.

Tungsten.—Scheelite is quoted at $24.00, Wolframite at $19. @ $24.00.

OTHER METALS

Bismuth, lb.	2.50–3.50
Cadmium, lb.	1.40–1.50
Nickel, electrolytic, lb.	.40
Silver, oz. (official)	.99½
Platinum, oz.	105.00
Palladium, oz.	135.00
Cobalt, lb.	2.50–3.50
Magnesium, lb.	2.00
Quicksilver, Cal.	125.00
Quicksilver, Mexican	118.00

The Iron and Steel Market

The distribution of pig iron and steel products, for some months to come if not for the duration of the war, was placed upon a clearly defined basis by the resolution of the War Industries Board, June 6. The actual distribution, however, is not greatly altered from the procedure that has obtained since the producers subscribed, at the close of April, to the pledge of 100 per cent efficiency for war work.

In order to explain briefly what has occurred it is desirable to adopt a nomenclature. One may define "war steel" as material that is ordered directly or indirectly by the government, for its own use or the use of its Allies, "commercial steel" being all other, irrespective of whether or not its employment is helpful towards winning the war. The nomenclature in comon use some time ago, classing industries as "essential" and "nonessential" became taboo in Washington some time ago, the preferable way of looking at the matter being to regard the industries as "more essential" and "less essential," though this is not good English.

For many months the war material has been under direct control of the War Industries Board through the medium of "priority certificates," but there is no precise definition of what classes of material may be the subject of such certificates. By the resolution of June 6 the War Industries Board recognizes three classes of material: (1) Material covered by its priority certificates, which are specific as to the tonnage and description of material involved in each certificate; (2) Material that is covered by a "schedule of purposes entitled to preference treatment" after the material covered by the priorities certificates is taken care of; (3) All other.

Class 2 is essentially the "more essential" material. It is to be distributed by the producers themselves, who are to ascertain from their customers the precise use intended for material furnished, and who are to report precisely each week the tonnages they have shipped, in detail. Hitherto they have reported specifically as to government order numbers, merely giving the total tonnage of all others.

Thus, as to the more essential uses, the War Industries Board prescribes precisely the uses, while the producers distribute the material as to actual tonnages to various customers. The distribution, in other words, is left in the hands of the producers, as they desired. Prior to the New York meeting of April 26 the War Industries Board had contemplated distributing this material also, perhaps by the same machinery of priority certificates as had been in use for war material.

Scope of Recognized Purposes

In form, it is a very drastic operation to cut off supplies of material to Class 3, when it embraces everything not covered by the two preceding classes, and when there is every prospect that there will be little if any material left to be distributed to Class 3. In actual fact, however, the tonnage requirements of Class 3 cannot be large, and material has been denied them almost entirely since the begining of May, and was quite largely denied them for months previously.

In actual fact, however, the deprivation is not great. Building of all descriptions falls in Class 3, unless it is in connection with either of the other classes, but as a matter of fact the building that fails to receive recognition has practically stopped already. There is scarcely any building except in connection with the war, yet in normal times building absorbs a very large part of the steel output. The largest single customer of the steel industry has been railroading, but not only railroads but also other means of transportation, including water transportation specifically mentioned, are named in the "schedule of purposes," while furthermore, since the railroads are under Federal control the specific lots of material required will doubtless be made the subject of priority certificates, and thus fall in the first class rather than the second.

The business of producing and transporting petroleum, and the business of mining coal have been large consumers of steel, but they are included in the schedule of purposes, as relating to fuel. The production and packing of food and the manufacture of clothing for the civilian population are likewise included.

After considering the circumstances referred to in the two preceding paragraphs, it is obvious that there is not much steel to be denied to anybody by reason of his receiving no recognition at Washington at this time. It must be considered further that the great war machine of the United States that is now getting into really powerful operation was not built from the ground up. It was not a case of building shipyards in their entirety, or shell factories, and recruiting them with men who were found outside the regular industries of the United States. Manufacturing facilities that had been always used for the fabrication or working up of iron and steel were largely employed, and thus both plant facilities and men have been diverted in their employment. Thus the normal consumption has largely disappeared in favor of the war consumption. One cannot erect a skyscraper, but the fabricating shops that ordinarily would take the order for the skeleton steel structure are busier than ever, making parts for fabricated ships.

While to individuals finding themselves in the "all other" or third class the dislocation will appear great, in point of tonnage the greatest shortage will be among those finding themselves in the second class, as there will hardly be enough steel to supply fully all their requirements.

Production

There is no material change in the rate of production, which in pig iron is running at between 41,000,000 and 42,000,000 tons a year, with supplies of coke very nearly adequate, and with much new by-product capacity in near prospect, but on the other hand with a period of a couple of months of high humidity facing the furnaces. If a rate of 41,000,000 tons a year is maintained over June, July and August reasonable expectations will have been met, although for a whole twelvemonth the capacity may be taken at not under 43,000,000 tons.

Production of ingots, relative to pig iron or finished rolled steel, is heavier than formerly by reason of the mills endeavoring to swell the production of war steel. This leads them to melt shell discard steel, sheet bar crops, etc., instead of rolling the material into merchantable form.

Prices

The existing set prices expire by limitation June 30 and before the end of the month the War Industries Board will take action on this matter. It is quite foreign to the board's views that there should be any price advances, unless in very special circumstances, and apparently its attitude at the end of March was that there ought to be reductions, but that such action could be deferred by reason of the furnaces and mills having had such poor operating conditions in January and February, so that they could have three months of good times to recoup. However, there was a wage advance of 15 per cent in April and the general advance in freight rates to become effective June 25 will amount to about $1.25 per ton in the manufacture of pig iron and about $2 a net ton in the manufacture of the average rolled steel product. Thus a general reduction in prices may be avoided. There will be no reduction unless the Federal Trade Commission finds the earnings have been running particularly large of late. The matter of large profits for taxation purposes hardly enters now, when the government is itself a very large buyer, but on the other hand the requirements are so large that it is more necessary than formerly to stimulate production to the last ton.

Chemical Market

Heavy Chemical:—During the past two weeks the movement in products under this classification has been rather more pronounced and quite a few more important transactions have transpired. Prices generally have ruled on a somewhat higher level and the tendency appears to be upward in most instances.

Caustic Soda:—The tendency of the market on this commodity has been toward a firm advance during the last two weeks and the trading has been quite active. The standard brands were being quoted at from $4.50 to $4.65 and in several instances $4.70 and $4.75 were spoken of. As to value there was a great difference of opinion in regard to prospects for the balance of the year or even for the next three months.

Soda Ash:—Since our last writing there has been a slight increase in acitivity accompanied by rising price demand. Against the quotations in our last issue of 2.60 and 2.70 for ash in barrels the offerings at this writing are 2.75 and 2.80 and from store there were a number of offers at from 2.90 to 2.95. Prices on bag material have also slightly advanced and the feeling is of a general underlying strength.

Sulphuric Acid:—The acid situation has developed some points of interest since our last report and the general opinion is that buyers will have difficulty in locating material from now on. The Government's requirements are becoming more pronounced and although there are interests that contend that acid in tanks can still be purchased at from $32.50 to $35.00 works, nevertheless they admit an increasing difficulty in obtaining offers from producers. Drum acid is reported to have sold as high as $55.00.

Oleum:—For twenty degree resale material there have been a few sellers at $55.00 tanks and $65.00 drums. The only producer of 60% material is reported as sold up.

Yellow Prussiate of Soda:—During the latter portion of the last two weeks period there has developed a slight depreciation in price as a result of more frequent offers and a lack of buying interest. Seventy cents was generally quoted although in one instance a possible buy at 68c was reported.

Bichromate of Soda:—Since our last writing which indicated an increasing inquiry interest with prices at 24½c and up to 25c the trend has continued upward and spot material is now held rather generally at from 26c to 26½c, for less than car quantities.

Copper Sulphate:—The inquiries for this product have continued active, quotations ranging around 9c. Many of the offers however undoubtedly are through second hands and have somewhat depressed the market to a slight degree as there developed possible purchases of standard brands of large crystals at 8.50.

COAL TAR PRODUCTS:—The demand for crudes is very quiet and the market in these products reflects considerable ease. Offerings are plentiful and there have been some declines in price registered. The intermediates are firm however and prices are quotably unchanged in most instances.

Benzol:—The market is very easy and offerings are reported of material at attractive prices. The consuming demand is very light and most sales have involved only small quantities.

Phenol:—The situation shows practically no change. The tone is easy with supplies of material continuing to be rather large. There are export inquiries reported that may absorb considerable material but up to the present the difficulty has been in the securing of export licenses for the War Trade Board.

Toluol:—Since the last report the Government through the Raw Materials Division of the War Trade Board has announced fixed prices for the release of toluol whether for non-military use or not. This action was taken in response to complaints from various sources that exorbitant prices were being paid by consumers in comparison with the price the government was paying. The established prices for original releases are 1.50 for large quantities and 1.55 for drums of any quantity. The market as far as real material is concerned shows no alteration and the business being transacted is very light. Releases being made to benzoate of soda producers do not seem to have benefited the resale situation at all.

Naphthalene:—Price declines have been noted and the market is confused with the liberal offerings being made of prime white flakes. Very attractive prices have been quoted for resale material. The ball material is also easier.

Benzoate of Soda:—There have been offerings at attractive prices recently but at the present time these appear to have been absorbed and a firmer appearance to the market is noted. The report has been circulated that the government will take over chlorine which may have added to the firmness which was experienced recently. The demand is fair.

Dimethylaniline:—Production continues to be confined to a few producers. There is fairly active demand and prices have held firm.

Paranitraniline:—Advances have been noted largely because of the acetic acid situation. The requirements of the market are said to be met with although production is confined to a few producers.

Aniline Oil:—With business of moderate proportions passing there is no change to record.

Beta Napthol:—The technical grade continues to be active. There is no change in the sublimed. The demand continues to be fair.

Alpha Napthylamine:—The easy tone evident in this product continues with fair business passing. The amount of supplies continues to meet present requirements.

Metatolumylenediamine:—The demand is unchanged and business of routine nature is passing. Prices show no change.

Paramidophenol:—With price levels unchanged there is a fair demand current.

Phthalic Anhydride:—Prices are firm. The demand is good and the trend seems to be upward.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JUNE 8, 1918

Acetic anhydride	lb.	1.50 —	1.60
Acetone, drums	lb.	Nominal	
Acid, acetic, 28 per cent	lb.	Nominal	
Acetic, 56 per cent	lb.	Nominal	
Acetic, glacial, 99½ per cent., carboys	lb.	Nominal	
Boric, crystals	lb.	.13½ —	.14½
Citric, crystals	lb.	.85 —	.87
Hydrochloric, C. P	lb.	Nominal	
Hydrochloric, 20 deg	lb.	.02½ —	.02½
Hydrochloric, conc., 22 deg	lb.	.02½ —	.03
Hydrofluoric, 30 per cent., in barrels	lb.	.08 —	.08½
Lactic, 44 per cent	lb.	.15 —	.15½
Lactic, 22 per cent	lb.	.06 —	.06½
Molybdic, 85 per cent	lb.	3.85 —	...
Nitric, 36 deg	lb.	Nominal	
Nitric, 42 deg	lb.	.09 —	.10
Oxalic, crystals	lb.	.43 —	.45
Phosphoric, 47–50 per cent. paste	lb.	.08 —	.10
Phosphoric, ref. 50 per cent	lb.	.26 —	...
Picric	lb.	Nominal	
Pyrogallic, resublimed	lb.	3.10 —	3.15
Sulphuric, 60 deg	ton	Nominal	
Sulphuric, 66 deg	ton	35.00 —	40.00
Sulphuric, oleum (Fuming), tank cars	ton	60.00 —	65.00
Tannic, U. S. P., bulk	lb.	1.30 —	1.35
Tartaric, crystals	lb.	.87 —	.88
Tungstic, per lb. of W	lb.	1.70 —	1.75
Alcohol, sugar cane, 188 proof	gal.	4.93 —	4.95
Alcohol, wood, 95 per cent	gal.	.90½ —	.91
Alcohol, denatured, 180 proof	gal.	.68 —	.69
Alum, ammonia lump	lb.	.04 —	.04½
Alum, chrome ammonium	lb.	.17½ —	.18
Alum, chrome potassium	lb.	.20 —	.21
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.08½ —	.09
Aluminium sulphate, technical	lb.	.02½ —	.03
Aluminium sulphate, iron free	lb.	.03½ —	.03½
Ammonia aqua, 26 deg. carboys	lb.	(Fixed Price)	
Ammonia, anhydrous	lb.	Nominal	
Ammonium carbonate	lb.	Nominal	
Ammonium nitrate	lb.	(Fixed Price)	.15
Ammonium, sulphate domestic	lb.	.07½ —	.08
Amyl acetate	gal.	5.40 —	5.50
Arsenic, white	lb.	.09 —	.16½
Arsenic, red	lb.	.60 —	.70
Barium carbonate, 99 per cent	ton	80.00 —	90.00
Barium carbonate, 97-98 per cent	ton	65.00 —	67.00
Barium chloride	ton	65.00 —	85.00
Barium sulphate (Blanc Fixe, Dry)	lb.	.02½ —	.02½
Barium nitrate	lb.	.09½ —	.10
Barium peroxide, basis 70 per cent	lb.	.30 —	.32
Bleaching powder, 35 per cent. chlorine	lb.	.01 —	.02
Borax, crystals, sacks	lb.	.07½ —	.08½
Brimstone, crude	ton	Nominal	
Bromine, technical	lb.	.75 —	...
Calcium, acetate, crude	lb.	Nominal	
Calcium, carbide	lb.	.16 —	.16½
Calcium chloride, 70-75 per cent., fused, lump	ton	27.50 —	30.00
Calcium peroxide	lb.	1.60 —	1.70
Calcium phosphate	lb.	.34 —	.35
Calcium sulphate 98-99 per cent	lb.	.09 —	.09½
Carbon bisulphide	lb.	.08½ —	.10
Carbon tetrachloride, drums	lb.	.15½ —	.16
Carbonyl chloride (phosgene)	lb.	1.10 —	1.50
Caustic potash, 88-92 per cent	lb.	.81 —	.83
Caustic soda, 76 per cent	100 lb.	4.60 —	5.00
Chlorine, liquid	lb.	(Fixed Price)	.07½
Cobalt oxide	lb.	1.60 —	1.65
Copperas	lb.	.01½ —	.01½
Copper carbonate	lb.	.30 —	.40
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent., large crystals	lb.	.08½ —	.09
Cream of tartar, crystals	lb.	.65 —	.85
Epsom salt, bags, U.S.P	lb.	.03½ —	.03½
Formaldehyde, 40 per cent	lb.	.17½ —	.18½
Glauber's salt	100 lb.	1.50 —	1.75
Glycerine, bulk, C. P	lb.	.63 —	.65
Iodine, resublimed	lb.	4.25 —	4.30
Iron oxide	lb.	.13 —	.15
Lead, acetate, white crystals	lb.	.17 —	.18
Lead, arsenate (Paste)	lb.	.15 —	.18
Lead nitrate	lb.	Nominal	
Litharge, American	lb.	.09½ —	.10½
Lithium carbonate	lb.	1.50 —	2.00
Manganese dioxide, U. S. P	lb.	.70 —	.75
Magnesium carbonate, technical	lb.	.15 —	.16
Nickel salt, single	lb.	.14 —	.15
Nickel salt, double	lb.	.12 —	.14
Phosgene, see Carbonyl chloride			
Phosphorus, red	lb.	1.30 —	1.50
Phosphorus, yellow	lb.	1.25 —	1.40
Potassium bichromate	lb.	.44 —	.46
Potassium bromide granular	lb.	1.35 —	1.50
Potassium carbonate calcined, 85-90 per cent	lb.	.40 —	.50
Potassium chlorate, crystals	lb.	.38 —	.40
Potassium cyanide, 98-99 per cent	lb.	Nominal	
Potassium iodide	lb.	3.75 —	3.80
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	325.00 —	350.00
Potassium nitrate	lb.	.27 —	.31
Potassium permanganate (U. S. P.)	lb.	3.10 —	3.40
Potassium prussiate, red	lb.	2.80 —	2.90
Potassium prussiate, yellow	lb.	1.15 —	1.20
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	Nominal	
Rochelle salts	lb.	.43 —	.44
Salammoniac, gray gran	lb.	.18 —	.19
Salammoniac, white gran	lb.	.17½ —	.18
Sal soda	100 lb.	1.35 —	1.40
Salt cake	ton	20.00 —	25.00
Silver cyanide, based on market price of silver	oz.	... —	...
Silver nitrate	oz.	.62½ —	.63
Soda ash, 58 per cent., light, flat (bags)	100 lb.	2.25 —	2.30

Soda ash, 58 per cent., dense, flat	100 lb.	4 00	—	4 10
Sodium acetate	lb.	Nominal		
Sodium bicarbonate, domestic	lb.	.02¾	—	.03
Sodium bicarbonate, English	lb.		—	
Sodium bichromate	lb.	.26	—	.26½
Sodium bisulphite, powd	lb.	.12	—	.13
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.39	—	.40
Sodium fluoride, commercial	lb.	.18	—	.19
Sodium hyposulphite	lb.	.02½	—	.02¾
Sodium molybdate, per lb. of Mo	lb.	2.50	—	
Sodium nitrate, 95 per cent	100 lb.	Nominal		
Sodium nitrite	lb.	.28	—	.30
Sodium peroxide	lb.	.35	—	.45
Sodium phosphate	lb.	.04	—	.05
Sodium prussiate, yellow	lb.	.69	—	.70
Sodium silicate, liquid (60 deg.)	lb.	Nominal		
Sodium sulphide, 30 per cent., crystals	lb.	.02½	—	.03
Sodium sulphide, 60 per cent., fused	100 lb.	5.50	—	6.00
Sodium sulphite	lb.	Nominal		
Strontium nitrate	lb.	.25	—	.35
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.60
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	Nominal		
Tin bichloride, 50 deg	lb.	.27½	—	.28
Tin oxide	lb.	1.00	—	1.25
Zinc carbonate	lb.	.25	—	.30
Zinc chloride	lb.	.12½	—	.13
Zinc cyanide	lb.	Nominal		
Zinc dust, 350 mesh	lb.	.14	—	.16
Zinc oxide, American process XX	lb.	.12½	—	.14
Zinc sulphate	lb.	.04½	—	.05

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	26	—	30
Benzol, 90 per cent	gal.		—	
Toluol, in tank cars	gal.	(Fixed Price)		1.50
Toluol, for non-military use, in drums	gal.	(Fixed Price)		1.55
Xylol, pure, water white	gal.	35	—	50
Solvent naphtha, water white	gal.	17	—	22
Solvent naphtha, crude, heavy	gal.	13	—	16
Creosote oil, 25 per cent	gal.	33	—	35
Dip oil, 20 per cent	gal.	29	—	30
Pitch, various grades	ton	8 00	—	20 00
Carbolic acid, crude, 95-97 per cent	lb.	1 05	—	1 10
Carbolic acid, crude, 50 per cent	lb.	60	—	65
Carbolic acid, crude, 25 per cent	lb.	35	—	38
Cresol, U. S. P	lb.	18	—	20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1 00	—	1 25
Alpha naphthol, distilled	lb.	1 60	—	2 00
Alpha naphthylamine	lb.	.58	—	.60
Aniline oil, drums extra	lb.	.26	—	.28
Aniline salts	lb.	.32	—	.34
Anthracene, 80 per cent	lb.	.50	—	.65
Benzaldehyde (f.f.c.)	lb.	5 50	—	6 00
Benzidine, base	lb.	1 75	—	1 85
Benzidine, sulphate	lb.	1 40	—	1 50
Benzoic acid U. S. P	lb.	3 75	—	3 90
Benzoate of Soda, U. S. P	lb.	3 30	—	3 50
Benzyl chloride	lb.	2 25	—	2 75
Beta naphthol benzoate	lb.	10 00	—	12 00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamine, sublimed	lb.	2.65	—	
Dichlor benzol	lb.	.12	—	.18
Diethylaniline	lb.	4 50	—	5 00
Dinitro benzol	lb.	.35	—	.40
Dinitrochlorbenzol	lb.	.40	—	.42
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.55	—	.60
Dinitrophenol	lb.	.46	—	.50
Dimethylaniline	lb.	.70	—	.72
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	2.30	—	3.00
Metaphenylenediamine	lb.	2.00	—	2.25
Monochlorbenzol	lb.	.17	—	.20
Naphthalene, flake	lb.	.09½	—	.09¾
Naphthalene, balls	lb.	.10½	—	.10¾
Naphthionic acid, crude	lb.	1.20	—	1.30
Naphthylamin-di-sulphonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.		—	
Ortho-dichlor-benzol	lb.	.15	—	.18
Ortho-toluidine	lb.	1.00	—	1.25
Ortho-nitro-toluol	lb.	.75	—	1.00
Para-amidophenol, base	lb.	3.50	—	3.75
Para-amido-phenol, H. Cl	lb.	4.00	—	5.00
Para-dichlor-benzol	lb.	.12	—	.15
Paranitraniline	lb.	1.60	—	1.70
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine (base)	lb.	3.50	—	4.00
Para toluidine	lb.	2.25	—	2.50
Phthalic acid anhydride	lb.	3.50	—	4.00
Phenol, U. S. P	lb.	.48	—	.49
Resorcin, technical	lb.	5.75	—	6.00
Resorcin, pure	lb.	8.50	—	9.00
Salicylic acid	lb.	.91	—	.95
Salol	lb.	1.90	—	2.00
Sulphanilic acid, crude	lb.	.30	—	.32
Tolidin	lb.	2.50	—	
Toluidine-mixture	lb.	.75	—	.87½

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	4.00	—	
Corning, Ohio	bbl.	2.85	—	
Somerset, Ky	bbl.	2.60	—	
Wooster, Ohio	bbl.	2.58	—	
Indiana	bbl.	2.18	—	
Illinois	bbl.	2.32	—	
Oklahoma and Kansas	bbl.	2.25	—	
Caddo, La., light	bbl.	2.25	—	
Corsicana, Tex., light	bbl.	2.35	—	
California	bbl.	1.23	—	
Gulf Coast	bbl.	1.35	—	

Fuel Oil

New York	gal.	.11	—	
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans	bbl.	1.05	—	2.75
Texas	bbl.	1.85	—	2.35
Los Angeles	bbl.	1.60	—	
San Francisco	bbl.	1.60	—	

Gasoline (Wholesale)

New York	gal.	.24	—	
Boston	gal.	.25	—	
Pittsburgh	gal.	.28	—	
Chicago	gal.	.22½	—	
Oklahoma	gal.	.25	—	
San Francisco	gal.	.20	—	

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.22	—	.24
Cylinder, light	gal.	.36	—	.38
Cylinder, dark	gal.	.35	—	.36
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, .903 sp. gr	gal.	.36	—	.38
Paraffine, .885 sp. gr	gal.	.26	—	.28

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	
Pine oil, steam-distilled, sp. gr. 0.925-0.940	gal.	.54	—	
Pine oil, destructively distilled	gal.	.49	—	
Pine-tar oil, sp. gr., 1.025-1.035	gal.	.35	—	
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.40	—	
Pine-tar oil, ref., light, sp. gr. 0.950, tank cars, f. o. b. works	gal.	.37	—	
Pine-tar oil, ref., heavy, sp. gr. 1.025, tank cars, f. o. b. works	gal.	.28	—	
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—	
Turpentine, crude, sp. gr. 0.870-0.900	gal.	.40	—	
Hardwood oil, f. o. b. Michigan, sp. gr. 0.960-0.990	gal.	.23	—	
Hardwood oil, f. o. b. Michigan, sp. gr. 1.06-1.08	gal.	.23	—	
Wood creosote, ref. f. o. b. Florida	gal.	.31	—	

Vegetable and Other Oils

China wood oil	lb.	.26	—	.27
Cottonseed oil, crude	lb.	.21	—	.22
Linseed oil, raw, cars	gal.	1.57	—	1.59
Peanut oil, crude	gal.	1.35	—	1.36
Rosin oil, first run	gal.	.45	—	
Rosin oil, fourth run	gal.	.63	—	
Soya bean oil, Manchuria	lb.	.16½	—	.16¾
Turpentine, spirits	gal.	.52	—	.52½

Miscellaneous Materials

Barytes, floated, white, foreign	ton	Nominal		
Barytes, floated, white, domestic	ton	32 00	—	36 00
Beeswax, white, pure	lb.	.62	—	.64
Casein	lb.	.14½	—	.18
Chalk, light, precipitated, English	lb.	Nominal		
China clay, imported, lump	ton	17 50	—	36 00
China clay, domestic, lump	ton	12 50	—	20 00
Feldspar	ton	8 00	—	12 00
Fluorspar, gravel, f. o. b. mines	ton	30 00	—	
Fuller's earth, powdered	100 lb.	1 00	—	1 50
Graphite, flake	lb.	.15	—	.18
Ozokerite, crude, brown	lb.	Nominal		
Ozokerite, American, refined, white	lb.	Nominal		
Red lead, dry, carloads	lb.	.10	—	.11½
Rosin, 280 lb	bbl.	7 50	—	
Soapstone	ton	10 00	—	12 50
Talc, American, white	ton	15 00	—	22 00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F. O. B. Works)

Chrome brick	net ton	175 00	—	
Chrome cement	net ton	75 00	—	
Clay brick, 1st quality firedlay	per 1000	50 00	—	55 00
Clay brick, second quality	per 1000	35 00	—	40 00
Magnesite, raw	ton	30 00	—	35 00
Magnesite, calcined, powdered	ton	50 00	—	65 00
Magnesite, dead burned	net ton	50 00	—	60 00
Magnesia brick, 9x4½x2½	net ton	110 00	—	125 00
Silica brick	per 1000	50 00	—	60 00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent., carloads, f. o. b. Niagara Falls, N. Y	ton		—	
Ferrocerium	lb.	15 00	—	20 00
Ferrochromium, per lb. of Cr	lb.		—	
Ferromanganese, domestic, 70 per cent. basis	ton	250 00	—	
Ferromanganese, English	ton	325 00	—	
Ferromolybdenum, per lb. of Mo	lb.	5 00	—	
Ferrosilicon, 75 per cent., f. o. b., N. Y	ton		—	
Ferrosilicon, 50 per cent., carloads, del., Pittsburgh	ton	180 00	—	190 00
Ferrosilicon, 50 per cent., contract	ton	160 00	—	170 00
Ferrotungsten, 75-85 per cent., f. o. b., Pittsburgh	lb.	2 35	—	2 40
Ferrouranium, f. o. b. works, per lb. of U	lb.	7 50	—	
Ferrovanadium, f. o. b. works	lb.		—	

Ores and Semi-finished Products

Antimony ore, per unit			—	
Chrome ore, 45 per cent minimum, f.o.b. Cal., per unit	ton	1.50	—	1.55
Chrome ore, 45 per cent. and over, New York, per unit	ton		—	
Manganese ore, 48 per cent. and over, per unit	ton	1.20	—	
Manganese ore, chemical	ton	80 00	—	100.00
Molybdenite, per lb. of MoS_2	lb.	1 25	—	
Tungsten, Scheelite, per unit of WO_3	ton	24.00	—	
Tungsten, Wolframite, per unit of WO_3	ton	24.00	—	
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium pentoxide, 99%	lb.	10.50	—	
Pyrites, foreign	unit	17	—	17½
Pyrites' domestic	unit	28	—	.30

INDUSTRIAL NEWS

Plant Construction—Catalogs—New Publications

Construction and Operation

Alabama

BIRMINGHAM—The Birmingham Machine & Foundry Co., East Birmingham, will rebuild part of its plant. Estimated cost, $100,000.

MOBILE—The Consumers Dye Wood Products Co., capitalized at $300,000, plans to build a large dye plant here. The foundations of the plant, which will be located at Choctawa Point, have already been put in. G. A. LaVelle, Marietta, O., president.

SHELBY, The Shelby Chemical Co. will build a plant for the manufacture of wood chemicals. Estimated cost, $600,000. M. W. Bush, President of the Shelby Iron Co., is interested.

WYLAM (Ensley P. O.)—The Steel Cities Chemical Co., 5 Mine St., Birmingham, will rebuild its plant here recently destroyed by fire.

Arkansas

TEXARKANA—The Texarkana Cotton Oil & Fertilizer Co., 600 East Broad St., will remodel its cotton seed oil mill.

California

LOS ANGELES—The Western Chemical Products Co., manufacturer of potassium permanganate and strontium nitrate, will erect a plant at Vernon.

MARE ISLAND—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., will build an addition to the machine shop at the north end of the Mare Island Navy Yard. Estimated cost, $350,000.

OAKLAND—The Hammer-Bray Foundry, foot of Twenty-sixth Ave., will build the second and third unit of its plant.

SAN FRANCISCO—The Pacific Foundry Co., Eighteenth and Harrison Sts., will build an 80 x 250 ft steel addition to its plant.

TEHACHAPI—The Gold State Mining Co. will install a thirty-ton mill here. Martin J. Errecarte, manager.

Colorado

BONANZA—The Rawley Mining Co. will build a three hundred ton mill here.

Connecticut

HARTFORD—The Colt Manufacturing Co., manufacturer of fire arms, Vandyke Ave., has awarded the contract for the construction of a one-story, 46 x 96 ft., reinforced concrete factory addition to Ellison Construction Co., 60 Prospect St. Estimated cost, $16,000.

HARTFORD—The Terry Steam Turbine Co., Windsor Ave., has awarded the contract for the construction of a one-story, 42 x 468 ft., brick mill construction factory addition to Ellison Construction Co., New Park Ave. Estimated cost, $45,000.

Illinois

CHICAGO—Fleischman Co., 427 Plum St., has awarded the contract for the construction of a four-story, 62 x 85 ft. steel and brick factory on Kingsbury and Weed Sts. for the manufacture of yeast, to H. W. Green Construction Co., 8 South Dearborn Sts. Estimated cost, $90,000.

CHICAGO—The Groen Manufacturing Co., copper-smiths, 2113 North Kenneth Ave., will build a one-story, 50 x 100 ft. brick factory. Estimated cost, $10,000. T. J. Reynertson, 1937 North Crawford Ave., architect.

CHICAGO—The Henry Lindahl Machine Co., Lake and Morgan Sts., has awarded the contract for the construction of a three-story, 50 x 100 ft., mill construction factory to R. L. Brockob, 2122 West Twenty-first St. Estimated cost, $60,000.

CHICAGO—Wilder & Co., 228 West Lake St., has awarded the contract for the construction of a five-story, 50 x 125 ft. reinforced concrete and brick factory for the manufacture of leather, to Mueller Construction Co., 179 West Washington St. Estimated cost, $75,000.

Indiana

ANGOLA—The Sevison Magneto Co. will build a factory here. Estimated cost, $29,000.

HAMMOND—The Standard Steel Car Co. has awarded the contract for the construction of a one-story, 150 x 400 ft. concrete, brick and steel factory for the manufacture of steel tires, to Austin Co., 16112 Euclid Ave., Cleveland, Ohio. Estimated cost, $100,000.

VINCENNES—The Marsh Co., Eleventh and Nicholas Sts., will build a one-story, 65 x 65 ft. addition to its factory to be used for the manufacture of drawn brass and steel tubing. Estimated cost, $32,000.

Kentucky

LOUISVILLE—J. B. Speed & Co., manufacturers of lime and cement, Speed Building, will build a potash plant seven miles from Louisville for the extraction of potash from the clay soil. Estimated cost, $100,000.

Kansas

WICHITA—The Universal Incinerator Manufacturing Co. will build a two-story, 50 x 100 ft. reinforced concrete, brick and steel factory. Estimated cost, $25,000.

Maryland

BALTIMORE — The Bartlett-Hayward Co., Scott and McHenry Sts., will enlarge its munitions plant. Estimated cost, $18,000,000. The company purchased something over 21 acres of land on Columbia Ave. several months ago and at the same time took under lease from the City Park Board a much larger area adjoining this tract and Carroll Park.

BALTIMORE—The Rockefeller Foundation, New York City, will build a seven-story, reinforced concrete and brick laboratory on Monument St. to be used by John Hopkins Medical School for research work. Estimated cost, $700,000. Archer & Allen, Central Savings Bank Building, architects.

GLENWOOD—The Baltimore & Ohio R. R., Baltimore, has awarded the contract for the construction of locomotive repair shops here, to Westinghouse, Church, Kerr & Co., 37 Wall St., New York City. Estimated cost, $1,700,000.

Massachusetts

BOSTON—Linde Air Products Co., 30 East Forty-second St., New York City, will build a one-story, 125 x 160 ft. reinforced concrete and brick factory for the manufacture of oxygen, on East First and K Sts. Estimated cost, $100,000. T. W. Goodrich, c/o owners, engineer.

CHELSEA—The Chelsea Foundry Co., 333 Third St., will build a one-story, 60 x 100 ft. foundry addition. Estimated cost, $15,000. S. S. Eisenberg, Exchange Building, architect.

HYDE PARK—The Mason Regulator Co., 1190 Adams St., Dorchester, has awarded the contract for the construction of a three-story, 80 x 160 ft. brick manufacturing building here, to John T. Scully Foundation Co., First St., East Cambridge. Estimated cost, $140,000.

ORANGE—The New Home Sewing Machine Co. has awarded the contract for the construction of a one-story, 103 x 353 ft., brick and steel plant for the manufacture of shells, to Casper Ranger Construction Co., Bond St., Holyoke. Estimated cost, $70,000.

ROXBURY—The Trustees of Harvard College, Harvard Medical School, Cambridge, will build a laboratory at 695 Huntington Ave. Estimated cost, $60,000. Coolidge & Shattuck, 122 Ames Building, Boston, architects.

Michigan

DETROIT—The Murchey Machine & Tool Co., Richmond Ave. and East Grand Boulevard, will build an addition to its plant.

MUSKEGON—The Campbell, Wyant & Cannon Foundry Co., Sanford St. and McKinney Ave., Muskegon Heights, has purchased ten adjoining lots and will build an addition to its plant.

PONTIAC—The Precision Castings Co. will rebuild its plant here which was partly destroyed by fire entailing a loss of $50,000.

Missouri

JOPLIN—The North American Mining Co., 715 Frisco Building, will build a concentrating plant at its mine, requiring sludge tables, compressors and crushers. Estimated cost, $60,000. W. R. Shanklin, 715 Frisco Building, mine engineer.

JOPLIN—Playter Bros. Mining & Reality Co., 315 Wall St., will build concentrating plant here. Estimated cost, $75,000. A. M. Brannon, trustee.

JOPLIN—The Reindeer Lead & Zinc Co. will build a one hundred and fifty-ton concentration mill at its mine here. Estimated cost, $40,000.

KANSAS CITY—The Butler Manufacturing Co., manufacturer of steel products, 1324 Grand Ave., will build a one-story, 125 x 270 ft. plant on Eastern Ave., Sheffield.

ST. LOUIS—The Moon Motor Car Co., 4401 North Main St., has received a $2,000,000 order for large shells for the army and will build extensive additions to its plant here. The McDonald Engineering Co. ,an engineering subsidiary, will assist in the manufacturing.

ST. LOUIS—The St. Louis Lead & Oil Works, Manchester and Sublette Aves., has awarded the contract for the construction of a reinforced concrete and steel paint factory, to Chapline Construction Co., Post Dispatch Building. Estimated cost, $15,000.

Montana

BOZEMAN—The Montana State College of Agriculture and Mechanic Arts, has awarded the contract for the construction of a chemical laboratory, to Kroffganz & Frank, Butte.

Nebraska

OMAHA—The Overland Rubber & Tire Co. has purchased a site of land running from Thirteenth St. to Thirty-first Ave. and from Taylor St. north, to the Missouri Pacific Belt line on the south, and will build a plant here for the manufacture of tires and tubes of all kinds both for automobiles and trucks, and a general line of mechanical and surgical rubber goods. Estimated cost, $2,000,000.

PLATTSMOUTH—The Auto Power & Malleable Manufacturing Co., 729 First National Bank Building, Omaha, will build a one-story, 80 x 240 ft. foundry of fabricated steel and glass on a site surrounded by Main, Pearl, Second and Third Sts. Estimated cost, $150,000.

New Jersey

BLOOMSBURY—The Warren Manufacturing Co., manufacturer of paper, will build large addition to its plant. E. H. Wenzelberger, Reading Building, Easton, Pa., is architect.

BOUND BROOK—The Calco Chemical Co., Bound Brook Road, will build additions to its plant. Estimated cost, $250,000.

ELIZABETH—Duesenberg Motor Corporation, Newark Ave., will build a brick testing plant. About $90,000.

HARRISON—The National Oil Products Co., Essex St., has acquired the plant here formerly owned and operated by the Elm Park Linoleum Works, Elm Park, Staten Island, and will equip same for its own use. The works comprise a twelve acre site with fourteen manufacturing buildings covering an area of about 250,000 sq.ft. floor space.

NEWARK—Martin Dennis Co., 859 Summer Ave., has awarded the contract for the construction of a one-story, brick factory for the manufacture of chemicals, to Salmon Bros., 526 Elm St., Arlington. Estimated cost, $30,424.

NEWARK—The Mass & Waldstein Co., 437 Riverside Ave., has awarded the contract for the construction of two one-story, 56 x 216 and 56 x 128 ft. brick buildings for the manufacture of chemicals, to H. M. Doremus Co., 36 Orange St. Estimated cost, $40,000.

NEWARK — The Mennen-Gerhardt Chemical Co., 40 Spring St., will alter its factory on Central Ave. Estimated cost, $42,500.

NEWARK—The Pierce-Butler & Pierce Manufacturing Co., 437 East One Hundred Sixty-second St., New York City, will build a one-story, 50 x 200 ft., concrete factory for the manufacture of steam and water boilers and plumbing fixtures on Colt St.

NEWARK—The United Oil & Chemical Co., Ave. R, will build a three-story addition to its plant.

PATERSON—The East Jersey Pipe Works, East Thirty-Sixth St., has purchased a site between 371 and 585 East Thirty-Second St., upon which a large addition will be erected.

New York

RIDGEFIELD PARK—The British American Chemical Co., 52 Vanderbilt Ave., New York City, has awarded the contract for the construction of factory buildings here, to Snare & Triest Co., 8 West 40th St., New York City.

BUFFALO—The National Aniline & Chemical Co., 351 Abbott Road, will build a three-story, brick and steel machine shop. Estimated cost, $85,000.

BUFFALO—The O'Neill Iron Works, 2e. Perry St., will build a one-story, brick and steel shop addition to its plant. Estimated cost, $45,000.

CORTLAND—The Cortland Specialty Co., 178 Railroad St., manufacturer of chemicals, will build an addition to its plant.

GLOVERSVILLE—G. Levor Co. has awarded the contract for the construction of a two-story, 65 x 115 ft. concrete and brick factory on Woodside Ave. for the manufacture of leather to A. E. Brace, 37 Hamilton St. Estimated cost, $35,000.

LONG ISLAND CITY—The Meurer Steel Barrel Co., 575 Flushing Ave., will rebuild its one and two-story, 200 x 255 ft. brick factory on Third and Oliver Sts. Estimated cost, $75,000. L. Allmendinger, 20 Palmetto St., Brooklyn, architect.

ROCHESTER—The High Speed Hammer Co., 307 St. Paul St., has awarded the contract for the cinstruction of a 60 x 115 ft. machine shop on Norton St., to Curran & Swartout Co., Granite Building. Estimated cost, $25,000.

Ohio

CANTON—The Timken Roller Bearing Co., Deuber Ave., has awarded the contract for the construction of new factory buildings, to J. E. Moss Iron Works, Wheeling, West Virginia.

CINCINNATI—The Cincinnati Gear Co., 1825 Reading Road, has awarded the contract for the construction of a one-story, 40 x 100 ft. concrete and brick addition to its factory to H. C. Hazen Co., 2070 Reading Road. Estimated cost, $30,000.

CINCINNATI—The Proctor & Gamble Co., Gwynne Building, will build a three-and one-half story, brick and concrete factory between East Ave. and Millcreek, Ivorydale. Estimated cost, $40,000.

CLEVELAND—The Cleveland Armature Co., 4732 St. Clair Ave., has awarded the contract for the construction of a two-story, 40 x 150 ft., reinforced concrete and brick factory, to the McMillin Co., 1794 East Fifty-Fifth St. Estimated cost, $20,000.

CLEVELAND—The Cleveland Pneumatic Tool Co., 3734 East Seventy-Eighth St., has awarded the contract for the construction of a one-story, 51 x 182 ft. concrete and brick factory, to Allen Osborn Engineering Co., 700 Rose Building. Estimated cost, $35,000.

CLEVELAND—P. A. Geier, manufacturer of machinery, 5100 St. Clair Ave., will build a one-story, brick addition to its plant. Estimated cost, $12,000. Watson Engineering Co., Hippodrome Building, engineer.

CLEVELAND—The Independent Glue & Gelatine Co., 2106 Woodland St., will build a two-story, 84 x 186 ft. brick factory on Broadway near Twenty-Eighth St.

CLEVELAND—The Reflex Ignition Co., 1788 Payne Ave., has purchased a site on West One Hundred and Sixth St. and will build a factory.

DAYTON—The Platt Iron Works, Keowee and Valley Sts., will build a one story metal factory. Estimated cost, $15,000.

MANSFIELD—The Rederick Lean Manufacturing Co., 366 Park Ave., East, will build a 100 x 420 ft. machine shop and tool room addition to its factory.

YOUNGSTOWN—The Raymond Concrete Pile Co., Andrews Ave., will build a 57 x 60 x 300 ft. brick factory for the manufacture of shells. Estimated cost, $30,000.

Oklahoma

BARTLESVILLE—The Bureau of Mines has awarded the contract for the construction of a two story, 37 x 57 ft. administration building and a 42 x 102 ft. laboratory, to D. M. Wall, 2617 Agnes St. Estimated cost, $30,000.

OKLAHOMA CITY—The Greater States Oil Corporation has purchased a forty acre site near Eastland upon which it will build an oil refinery. Estimated cost, $200,000.

TULSA—The Lampblack Manufacturing Co. will build a plant for the manufacture of lampblack from natural gas.

WALTERS—The United States Refinery Co. has purchased an eighty acre site here on which it will build an oil refinery. Estimated cost, $60,000.

Oregon

ASTORIA—The Astoria Paper Mills will build an addition to its plant. Estimated cost, $250,000.

Pennsylvania

BRISTOL—The Atlantic Refinery Co., 3144 Passyunk Ave., Philadelphia, has awarded the contract for the construction of a one story addition to its plant here, to Metzger & Fisher, Otis Building, Philadelphia.

PHILADELPHIA—The Barrett Co., Margaret and Bermuda Sts., has awarded the contract for the construction of a five story, 100 x 150 ft. reinforced concrete and brick factory for the manufacture of coal tar products, to A. R. Raff Construction Co., 1616 Thompson St. Estimated cost, $40,000.

PHILADELPHIA—Berko Bros., Randolph and Wood Sts., manufacturer of structural steel, has awarded the contract for the construction of a one-story, 18 x 50 ft. brick wire factory, to M. Yellin, 712 North Franklin St. Estimated cost, $5,000.

PHILADELPHIA—The Powers-Weightman-Rosengarten Co., 916 Parrish St., manufacturer of chemicals, will build a one-story, 55 x 70 ft. addition to its plant at Ridge Ave. and Calumet St.

PITTSBURG—The Atlantic Refining Co., Fifty-Seventh and Butler Sts., will build a pressure still at its plant. Estimated cost, $50,000.

READING—The International Money Machine Co., Kutztown Road, has awarded the contract for the construction of a two story, 40 x 45 ft. and a one story, 60 x 142 ft. concrete and steel factory buildings, to Austin & Co., Bulletin Building, Philadelphia. Estimated cost, $50,000.

Rhode Island

NEWPORT—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids June 3rd for building a chemical laboratory at the U. S. Naval Torpedo Station, from T. A. Cassidy, 54 Ballston St., Fitchburg, Mass., $37,571; C. B. Maguire, Providence, $34,955; Darling Slade Construction Co. Newport, $36,000.

Texas

COLEMAN—The Lone Star Oil & Refining Co., Manes Building, will erect an oil refinery to have a daily capacity of 500 barrels. Estimated cost, $50,000.

HOUSTON—The Ka-Tex-O Oil & Refining Co. will build a large oil refinery here.

Virginia

PORTSMOUTH—The Lime-Kola Co. will build a flavoring extract plant at 611 Edwards St.

Washington, D. C.

WASHINGTON—The Bureau of Yards & Docks, Navy Department, has awarded the contract for the construction of a mine laboratory, to Sumner Sollitt Co., Pullman Building, Chicago, Ill. Estimated cost, $73,000.

Washington

SEATTLE—The American Foundry Co., 408 Occidental Ave., recently organized, will build an iron foundry with a daily capacity of fifteen to twenty tons.

SEATTLE—The Ark-O-Lith Products Co. will build a two story 53 x 108 ft. factory at 421 Wilton St. for the manufacture of building blocks, artificial marble and fireproof doors.

SEATTLE—Gulowsen & Grei Co., Alaska Building, will build a one story, 174 x 300 ft., mill construction, Grei engine manufacturing plant on Salmon Bay. Estimated cost, $400,000. S. E. Sonnichsen, Downs Block, architect.

SEATTLE—The Hefferman Engine Works, 108 Railroad St., will build a two story, 50 x 174 ft. machine shop. Estimated cost, $25,000.

SEATTLE—The Pacific Engineering & Construction Co. will build a one story, 70 x 120 ft. addition to its machine shops and foundry.

West Virginia

HUNTINGTON—The Chesapeake & Ohio Railroad Co., Richmond, Va., will build a one story machine shop here. Estimated cost, $500,000. F. I. Cabill, Richmond, chief engineer.

WESTON—State Board of Control is having plans prepared for sewage treatment plant for Weston State Hospital. The plant will consist of pumping plant, sedimentation tank, sprinkling filter, disinfecting plant and incinerating plant. Estimated cost, $45,000. Charles E. Allins, Drexel Building, Philadelphia, Pa., engineer.

Wisconsin

MILWAUKEE—The National Brake & Electric Co., foot of Belleview Place, will build an iron foundry, concrete and steel. Estimated cost, $75,000. H. J. Esser, 402 Camp Building, architect.

MILWAUKEE—The Wisconsin Wire & Iron Co., 1660 Booth St., will build an addition to its factory here. Estimated cost, $2500.

WAUWATOSA—The Milwaukee Pattern Manufacturing Co., Thirtieth and Locust Sts., will build a 50 x 74 ft. brick pattern shop.

WYOMING PARK—The Hacket Motor Co. has awarded the contract for the construction of a one story, 70 x 100 ft., brick and steel factory to J. W. Clark, Grand Haven.

Wyoming

WORLAND—The Petroleum Gas Products Co., Exchange Building, San Francisco, Cal., has purchased the Hidden Dome field here and will build an absorption plant. Estimated cost, $500,000.

Ontario

BRANTFORD—The Motor Trucks Co., Ltd., Elgin St., has awarded the contract for the construction of a brick and steel shell factory, to P. H. Secord & Sons. Estimated cost, $175,000.

HAMILTON—The Dominion Steel Foundry Co., Depew St., will build a new plant. Estimated cost, $2,500,000.

OWEN SOUND—The Great Lakes Steel Corporation, Ltd., 22 King St., East, Toronto, has purchased a factory here which it will remodel for the manufacture of steel products.

TILBURY—The Canadian Forgings & Socket Co. will build a munitions plant here. Estimated cost, $200,000.

WINDSOR—The Menard Motor Truck Co., 100 London St., West, will build a three story brick factory. Estimated cost, $60,000. M. L. Menard, 10 Carson St., is manager.

Canada

DESCHENES—The British American Nickel Corporation, Royal Bank Building, Toronto, has awarded the contract for the construction of a copper regning plant here, to Bate, McMahon & Co., Ottawa. Estimated cost, $1,000,000.

LONGUE POINTE—The Montreal Locomotive Works, 145 St. James St., Montreal, will build an addition to its plant here.

MONTREAL—The Canadian Allis Chalmers, Ltd., 162 St. Antoine St., will build a concrete, brick and steel addition to its Rockfield plant here. Estimated cost, $25,000.

Industrial Notes

THE DENVER FIRE CLAY COMPANY, Denver Colo., founded in 1876, has recently been reorganized as a result of the purchase of the entire interest held by Willis W. Case, Jr., by Mrs. Leonora Bosworth, wife of the founder of the business, and her three sons. Arthur H., senior member of the firm Bosworth, Chanute & Company, Denver; Harold O., of New York, and Capt Robert B., an attorney of Denver, now in the American military service in France. This company specializes in clay products for assaying and other metallurgical work, produced from its own fire-clay deposits near Golden, Colo. The company is also a large importer and exporter of all kinds of chemicals for laboratory and industrial purposes. The officers of the new company are as follows: President, Harold O. Bosworth, who was formerly active in the company for 10 years, but recently manager of the White Tar Company of New York; Vice-president J. Claire Evans, recently manager of the assay department of the Mine & Smelter Supply Company, Denver; Secretary-Treasurer Herman Landenberger, who has been connected with the company for 20 years. George W. Lindsay will be factory superintendent.

The SHAWINIGAN ELECTRO-METALS COMPANY, LTD., Montreal, one of the pioneers in the production of magnesium in America, has established a sales office in the Leader-News Building, Cleveland, O. Mr. D. P. Falconer is the sales agent.

The NATIONAL ANILINE AND CHEMICAL COMPANY transferred its exhibit of colors recently shown at the Textile Show to the "Made in U. S. A." exposition at the Jordan March Company of Boston. The exhibit was particularly applicable to the purpose of the Jordan March Company because of the manner in which it demonstrates the growth and importance of the American dye industry.

The SIDIO COMPANY OF AMERICA, INC., has built and equipped a new factory, 721-733 East 133rd Street, New York City. The new building was occupied on April 25 and the company is now in a position to make any article of fused silica demanded by the trade.

The BOOTH-HALL COMPANY announce contracts recently received for the following units: A 1-ton furnace for the Queen City Foundry Company, Denver, Col., which is at present operating a converter steel foundry. A 2-ton furnace for the Monroe Steel Casting Company, Monroe, Mich., which is at present operating a single-phase electric furnace which will be replaced by the new unit. A 2-ton furnace for the New England Steel Casting Company, a new steel foundry which will be located at Springfield, Mass. A 2-ton furnace for the Four-Wheel Drive Auto Company, Clintonville, Wis., which is installing a new steel foundry to produce castings for trucks for the United States government. A 2-ton Booth-Hall furnace has recently been put into operation in the new steel foundry of the Avery Company, Peoria, Ill., for producing gears, pinions, and other agricultural machinery and tractor castings. A 1-ton unit is ready to be put into operation at the plant of the Duriron Castings Company, Dayton, Ohio. With the 5-ton unit which has been in operation at the Midland Electric Steel Company, Terre Haute, Ind., this makes three sizes of furnaces that the Booth-Hall Company has designed and put in operation.

The Everly N. Davis Chemical Corporation is a new company formed for the specific purpose of equipping and operating the new picric acid plant which is to be built by the War Department at Little Rock, Ark. Everly N. Davis, the president of the company, was formerly president of the Butterworth-Judson Corporation. The new company has just opened offices at 25 West 44th Street, where they are interested in hearing from reliable manufacturers of chemical equipment which they shall need in their plant.

The DRIVER-HARRIS COMPANY of Harrison, N. J., announces the election of the following officers: Frank L. Driver, president; Arlington Bensel, 1st vice president; Leon O. Hart, 2nd vice president; Frank L. Driver, Jr., 3rd vice president; Percival E. Reeves, treasurer; Stanley M. Tracy, asst. treasurer; M. C. Harris, secretary. Mr. Wilbur B. Driver, formerly vice president, has retired from active participation in the business.

The BROWN HOISTING MACHINERY Co. announces the appointment of Mr. H. D. Wright, manager of the San Francisco office, as Pacific Coast representative, to succeed the Colby Engineering Company in the Northwest territory.

The BROWN INSTRUMENT COMPANY, Philadelphia, has opened a new office at 2086 Railway Exchange Building, in charge of Mr. Paul H. Berggreen. The new office is established to meet the demands of business in the Southwestern part of the country.

The MARDEN, ORTH & HASTINGS CORP., Cleveland, O., branch, moved into new offices in the Illuminating Building. The Cleveland office is in charge of Mr. Henry W. Galley, and takes care of all the trades using colors, chemicals and industrial and edible oils in the State of Ohio and in the Pittsburgh, Pa., and Louisville, Ky., districts.

FULLER-LEHIGH COMPANY is the style of the merger of the property and plants of the Lehigh Foundry Company and the Lehigh Car, Wheel & Axle Works of Fullerton, Pa. The properties of the two companies are adjoining and have been for a number of years under the same management. The change is one of name only. The executive personnel remains the same, and the same high standards of quality of products and efficiency of service established in the past will be maintained. The office and works are at Fullerton, Pa.

MITSUI AND CO., LTD., announce the removal of their office to 65 Broadway, New York City.

The JOSEPH DIXON CRUCIBLE COMPANY announces the election of the following directors and officers at the last annual meeting: Directors: George T. Smith, William G. Bumsted, J. H. Schermerhorn, George E. Long, Edward L. Young, Harry Dailey, Robt. E. Jennings. Officers: George T Smith, president; George E. Long, vice president; J. H. Schermerhorn, vice president; Harry Dailey, secretary; William Koester, treasurer; Albert Norris, asst. secretary and asst. treasurer.

The AMERICAN GRAPHITE COMPANY, a subsidiary of the Joseph Dixon Crucible Co., has the same directorate as the Joseph Dixon Crucible Co. and the following officers: George T. Smith, president; George E Long, vice president; J. H. Schermerhorn, treasurer; Harry Dailey, secretary.

COLORADO IRON WORKS COMPANY announces the removal of its Eastern office to 30 Church Street, New York City.

SIR ISAAC PITMAN & SONS, LTD., announces the recent purchase of all the existing copyrights of the numerous scientific and technical books previously issued by Messrs. Whittaker & Company of London, and in future the American agency for these works will be controlled by Isaac Pitman & Sons, 2 West 45th Street, New York. This series includes many important works relating to aeroplanes, submarines, wireless telegraphy, etc.

The WILPUTTE COKE OVEN CORPORATION has been awarded a contract for the construction of forty (40) Wilputte ovens, with extensions to the existing byproduct plant and benzol plant, by the Citizens Gas Company of Indianapolis. Work has been started and the plant is expected to be in operation by December, 1918.

THE WHEELER CONDENSER & ENGINEERING Co., Carteret, New Jersey: Bulletin 108-B on centrifugal pumps, illustrating the turbine-driven geared centrifugal pumps; bi-rotor, tri-rotor; electric driven; small belt-driven; small high-speed; side, end and bottom suction; vertical shaft; pumps for either series or parallel operation; and special slow-speed engine driven pumps. Test curves made by both manufacturer and customer are included.

CLARAGE FAN COMPANY, Kalamazoo, Michigan, Catalog No. 7 on section drying cabinets giving details of dryer and prices.

THE CUTLER-HAMMER MFG. Co., Milwaukee, Wis.; a folder illustrating and describing C-H sectional battery charging equipment for industrial electric trucks. Also a folder, No. 233, on C-H Industrial Stores.

THE WALTER A. ZELNICKER SUPPLY COMPANY, St. Louis, Mo.; Bulletin No. 243, May 14, 1918, on power plant equipment and machinery for immediate shipment.

THE ARMSTRONG CORK & INSULATION COMPANY, Pittsburgh, Pa.; a booklet entitled "Satisfaction or ——" which deals with the subject of industrial drinking water systems. Copies will be supplied upon request.

THE M H-ATERITE COMPANY, Inc., 55 John Street, New York; Bulletin No. 4, Jan. 1, 1918, on special information for superintendents of oil refineries in relation to valves, fittings, etc.

THE LOCOMOTIVE PULVERIZED FUEL COMPANY, 30 Church Street, New York; Bulletin 4, March, 1918, on the use of powdered coal or lignite with "Lopulco" combination feeder and mixer.

THE ALLIS-CHALMERS MANUFACTURING COMPANY; Bulletin 1454, January, 1918, on their dust collector.

THE BUFFALO FORGE Co., Buffalo, N. Y.; Sections No. 100 and 108 describing portable and stationary forges.

J. H. MATHEWS & SONS, Wellsburg, West Va.; a booklet entitled "Builders of Glass Works."

GEM STOPPER COMPANY, Philadelphia, Pa., Bulletin No. 8, January, 1918, on universal acid carboy stoppers, asbestos gaskets and metal fasteners.

New Publications

TYCOS GRAVITY AND TEMPERATURE TABLES for Mineral Oils from Determinations of the Bureau of Standards and Other Tables for General Testing and Refinery Practice. Compiled and edited by E. N. Hurlburt. Published by the Taylor Instrument Companies, Rochester, N. Y. Price, $1.00.

REPORT OF A CONFERENCE held under the auspices of the Committee on Work in War Industries of the National War Work Council, Young Men's Christian Association. Among the speakers were Judge E. H. Gary, A. C. Bedford, John J. Eagan, and others.

THE ROCKEFELLER FOUNDATION. A review of its war work, public health activities, and medical education projects in 1917. By George E. Vincent.

UNIVERSITY OF TEXAS BULLETIN, No. 1752, Sept. 15, 1917. Boiler Waters; Their Chemical Composition, Use, and Treatment. By W. T. Read, Chemist, with a preface by E. P. Schoch, head of the Bureau of Economic Geology and Technology Division of Chemistry.

NEW GEOLOGICAL SURVEY REPORTS: Lime in 1916. By G. F. Loughlin; Mineral Waters in 1916. By Arthur J. Ellis, with a comparison of American and European mineral waters. By Alfred A. Chambers; Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1916. By C. N. Gary; and Copper in 1916 (general report). By B. S. Butler.

NEW BUREAU OF MINES PUBLICATIONS: The Use of Permissible Explosives in the Coal Mines of Illinois. By James R. Fleming and John W. Koster, Bulletin 137; Concentration Experiments with the Siliceous Red Hematite of the Birmingham District, Alabama. By Joseph T. Singewald, Jr., Bulletin 110; Oil-Storage Tanks and Reservoirs, with a brief discussion of losses of oil in storage and methods of prevention. By C. P. Bowie, Bulletin 155; and Initial Priming Substances for High Explosives. By Guy B. Taylor and W. C. Cope, Technical Paper No. 162.

THE STORAGE OF BITUMINOUS COAL. By H. H. Stoek, University of Illinois. Bulletin Vol. 15, No. 27. A 200-page pamphlet issued in view of the recent coal shortage. It is the purpose of the circular to present a review of modern practice governing the storage of coal. The discussion is confined to bituminous coal which has given so much trouble owing to its tendency toward spontaneous combustion while stored. Another pamphlet bearing on the same subject is Technical Paper No. 172 of the U. S. Bureau of Mines, "Effects of Moisture on the Spontaneous Heating of Stored Coal" by S. H. Katz and H. C. Porter.

THE THERMAL TESTING PLANT. By R. B. Fehr. Bulletin No. 24 of the Engineering Experiment Station, of the Pennsylvania State College. A report on the work of the testing plant for the years 1916 and 1917, describing apparatus and method of testing, calibration of instruments, etc.

Manufacturers' Catalogs

THE GALVANIZING CORPORATION OF AMERICA, Brooklyn, N. Y.; a booklet on Electro-Galvanizing the "Standard" Way, showing the advantages of lime as a protective agent.

LUDLUM STEEL COMPANY, Watervliet, N. Y.; a catalog on the manufacture of steel and the use of various alloy elements. The language employed throughout the catalog is that of the shop man and not the metallurgist. This catalog and treatise on the allotropy of steel and the alloying of steel is for distribution, free of charge.

THE HYDRAULIC PRESS MFG. Co., Mount Gilead, Ohio; a new catalog on hydraulic valves and fittings, describing this company's complete line, including hydraulic presses, pumps, accumulators and intensifiers for every high-pressure purpose. Copies may be had by addressing the above company.

THE HARSHAW FULLER & GOODWIN COMPANY, Cleveland, Ohio, a book on "Enamels" by Robert D. Landrum. This book is a collection of various articles published by the author in the different technical journals.

LINK-BELT COMPANY, Chicago, Ill.; Book No. 312 on the silent chain, the efficient drive for machine tools.

THE TITANIUM BRONZE COMPANY, Inc., Niagara Falls, N. Y.; a booklet on high-conductivity copper castings.

THE UNITED FILTERS CORPORATION, Brooklyn, N. Y., has issued three bulletins, Nos. 100 to 102 inclusive, covering Kelly and Sweetland pressure leaf-type filters, also the American continuous vacuum filter.

W. S. ROCKWELL COMPANY, 50 Church Street, New York: Bulletin No. 34 on forging and heating furnaces describing the Economzer shield type, issued May, 1918; Bulletin No. 35 on annealing furnaces, rolling mill type.

MONARCH ENGINEERING & MANUFACTURING COMPANY, Baltimore, Maryland: A bulletin describing the new Monarch vertical non-crucible tilting metal melting furnace.

THE PFAUDLER Co., Rochester, N. Y.: Bulletin C5 on glass enameled steel equipment for the chemical industries.

COLORADO IRON WORKS COMPANY, Denver, Colorado: Catalog No. 28-C on the continuous filtration with the Portland filter, distributed in the East by the Colorado Iron Works Company, 30 Church St., New York City.

HOSKINS MANUFACTURING Co., Detroit, Mich.: Catalog No. 3, April, 1918, on Hoskins pyrometers and chromel couples.

JAMES G. BIDDLE, 1211-13 Arch Street, Philadelphia: A bulletin on Biddle's engineering specialties for testing.

THE HARRIS CALORIFIC Co., Cleveland, Ohio: A bulletin on high temperature gas apparatus and also welding and cutting of metals.

WHEELER CONDENSER & ENGINEERING COMPANY, Carteret, N. J.: A catalog on the Lillie evaporator for waste waters, including tank waters, runaway waters, distillery slops, steffins waters, etc.

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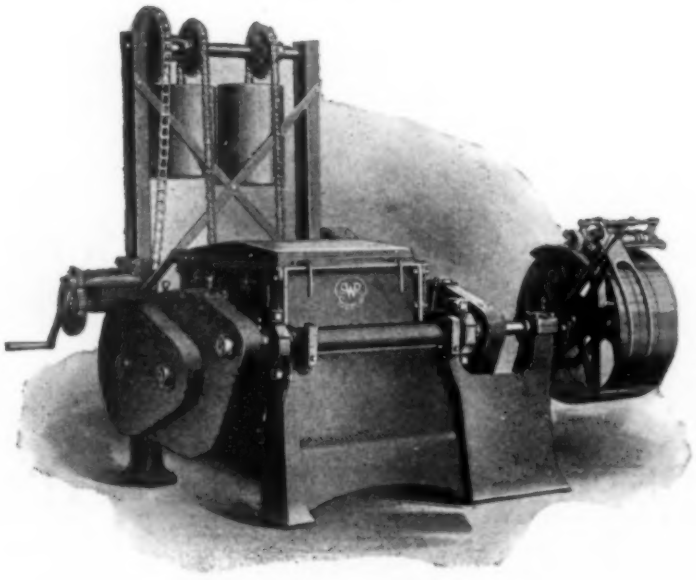

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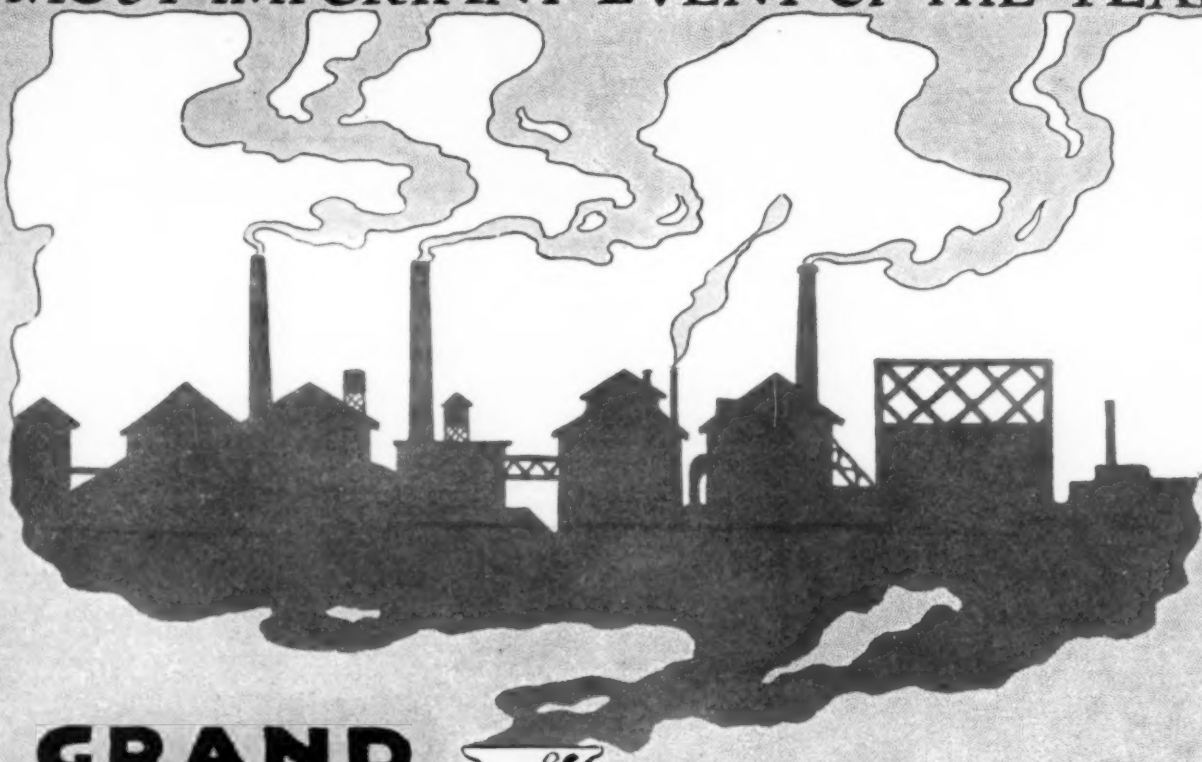
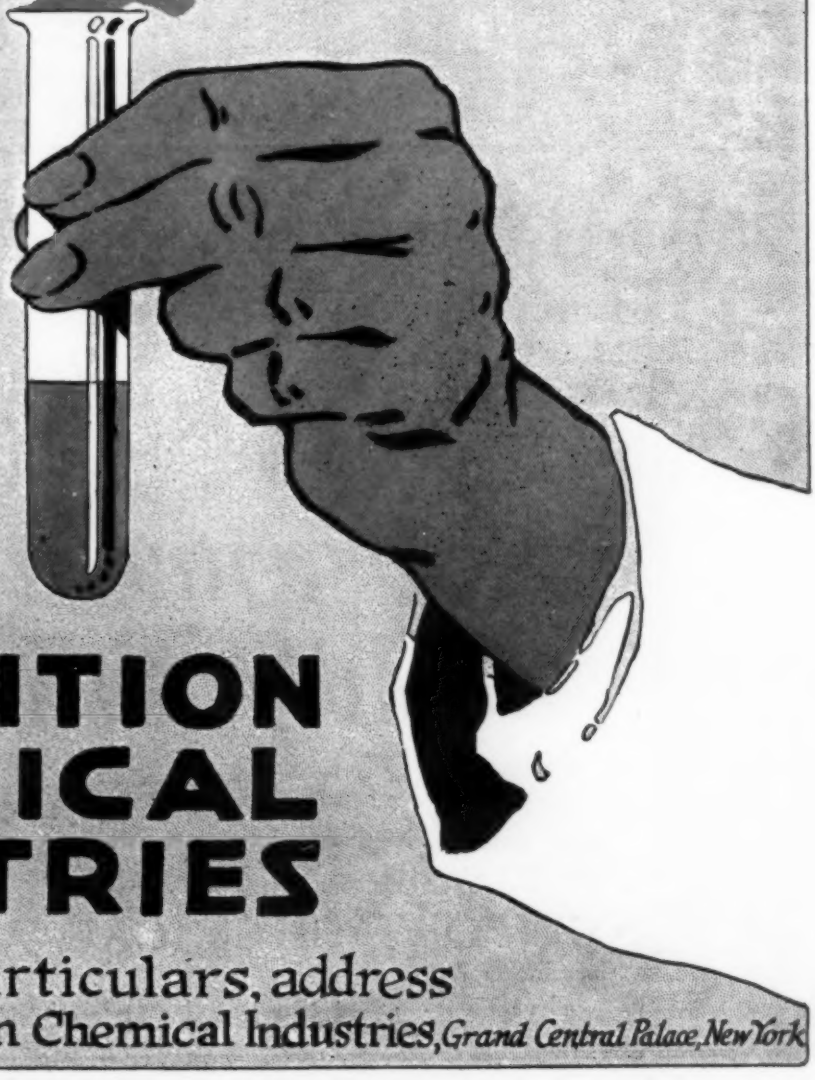


GRAND CENTRAL PALACE

NEW YORK

WEEK OF SEPT. 23 -1918-



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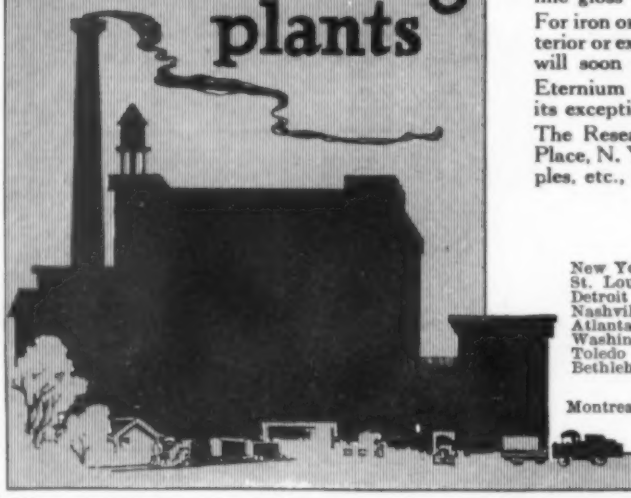

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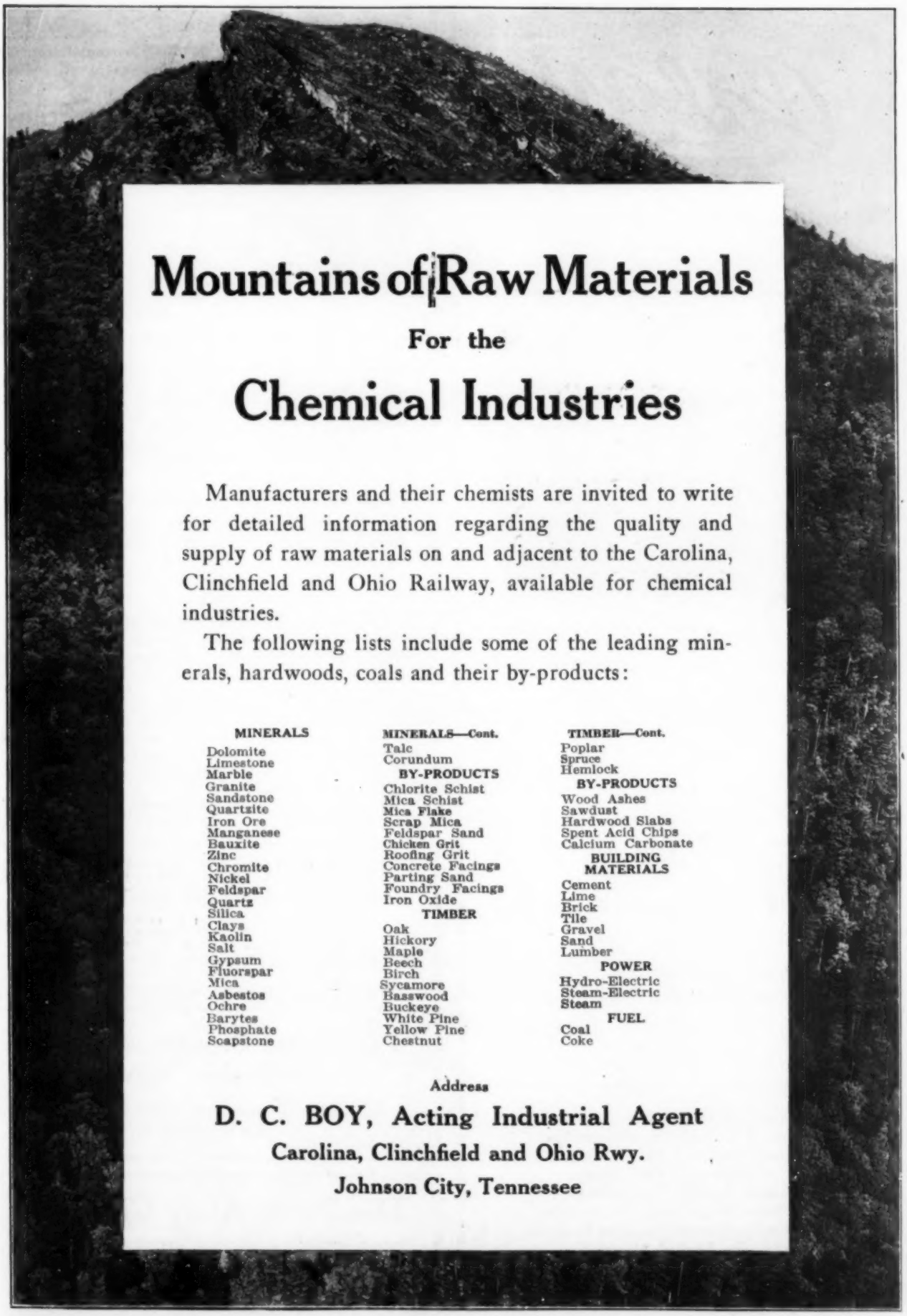

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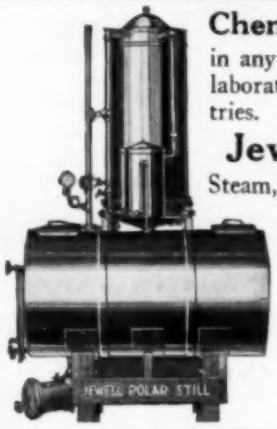

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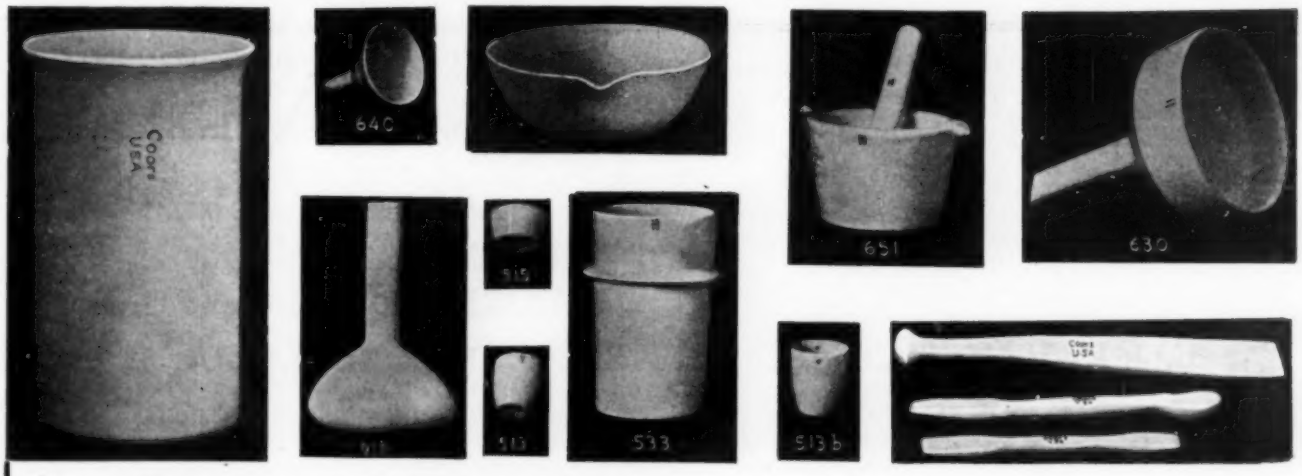

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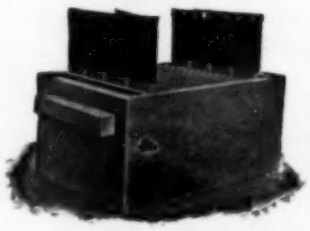
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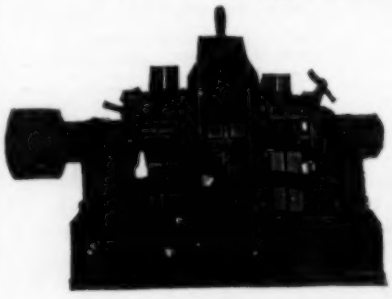

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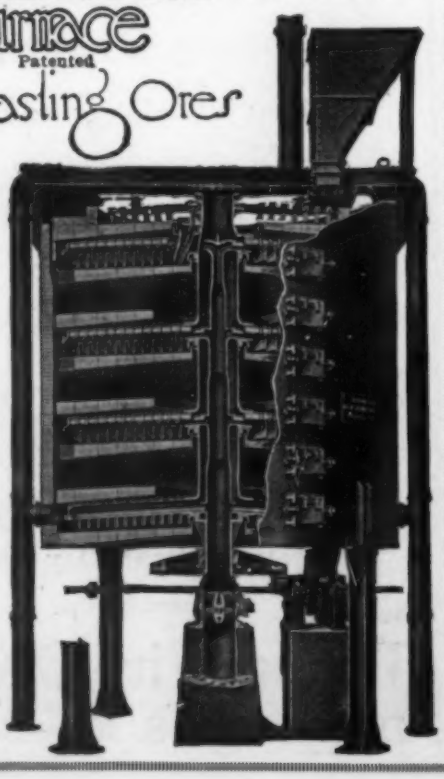

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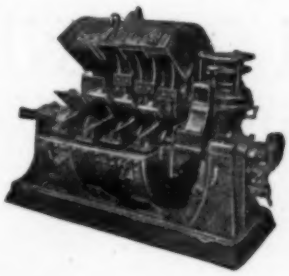

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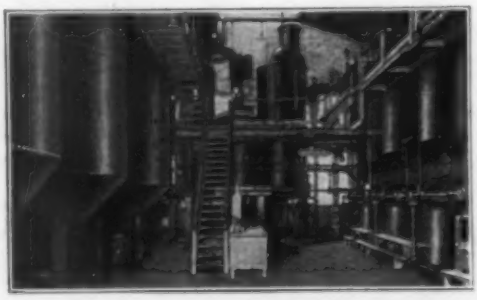
Chlorine Gas, Caustic Soda and Bleach Liquid Chlorine, Mono Chlor Benzol and other Chlorine Derivatives

—ADVANTAGES—

(a) Saving 50% floor space
(b) Automatic regulation of temperatures
(c) Highest cell efficiency
(d) Low cost of installation, maintenance and repairs

Showing completion of $2,000,000 Smelting and Electrochemical plant

Cell room of plant having total capacity of 8 to 9 tons of chlorine per day



Brine and evaporator department. Total capacity 10 tons Caustic Soda per day

Proposals furnished covering complete chemical munitions and dyestuff plants. We are equipped with a staff of competent engineers and chemists with years of practical operating experience in production of chlorine and special compounds—organic and inorganic.

Electrolytic Engineering Corporation
501 Fifth Ave., New York City

VULCAN KILNS
Nationally Used

Vulcans are the most widely used kilns in America. Every detail in their design and making calls for the mechanical judgment of specially trained engineers. Every part entering into kiln construction must be in tune with the conditions under which it must operate.

No matter what your kiln requirements are, there is a Vulcan that will meet them exactly—quickly, economically and efficiently.

Our engineers are ready and willing to assist and advise you. Perhaps, also, you would like to know the names of some of the Vulcan users.

Write us now. Your request will bring a fund of valuable information.

VULCAN IRON WORKS
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Chain Screens

Avoid chilling the furnace
Protect operators from heat

Chains do not interfere with charging and discharging Furnaces. Heat is saved and workmen are more content.

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NEW AIR-TIGHT BLAST GATE
FOR LOW AND MODERATE PRESSURE AIR

(Patented)

Save that air (money) you are now losing thru leaky blast gates. Our NEW AIR-TIGHT BLAST GATE stops this loss.
Circular 123-H explains its many other advantages, outlining clearly its all-around superiority over the ordinary light, flimsy, cheap, leaky and unreliable blast gates, and the heavy, cumbersome, expensive and slow-acting gate valves and stop cocks.
Ask for circular and list of users.

W. S. ROCKWELL COMPANY
Furnace Engineers and Contractors
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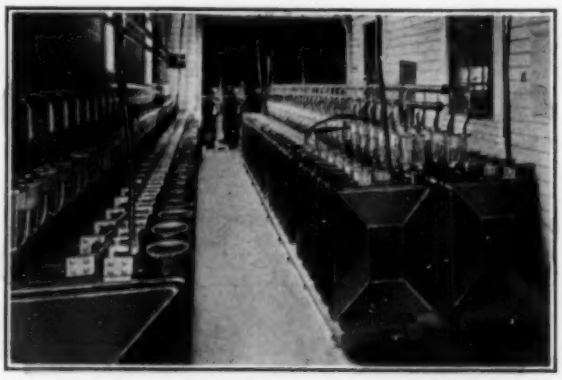


First Installation of 100 Levin Cells for the Portland Oxygen & Hydrogen Co., Portland, Oregon

Make your own oxygen and hydrogen with the

Levin Generator

Purity of 99.8% and better

The Levin will produce your oxygen at one-third the price you pay for it in cylinders, and in addition you will get all the hydrogen for nothing. This is a conservative estimate into which we have not figured the storage, handling and returning of cylinders, bookkeeping—the unavoidable 15% loss, etc.

We will take entire responsibility for putting in the entire plant, and the floor space required will be no greater than the room required to store cylinders.

May 9, 1917.

Electrolabs, N. Y.

Our congratulations on your cells. Efficiency 10% better than your guarantee. Oxygen purity 99.85%.

Portland Oxygen & Hydrogen Co.

Nov. 20, 1917.

Electrolabs, N. Y.

Cells have continuously exceeded guarantee in production and purity. So far as we can determine, the hydrogen is absolutely pure.

Portland Oxygen & Hydrogen Co.

May 21, 1918.

Electrolabs, N. Y.

Advise us when you can ship 200 more generators.

Portland Oxygen & Hydrogen Co.

ELECTROLYTIC OXY-HYDROGEN LABORATORIES, INC.

I. H. LEVIN, *Technical Director*

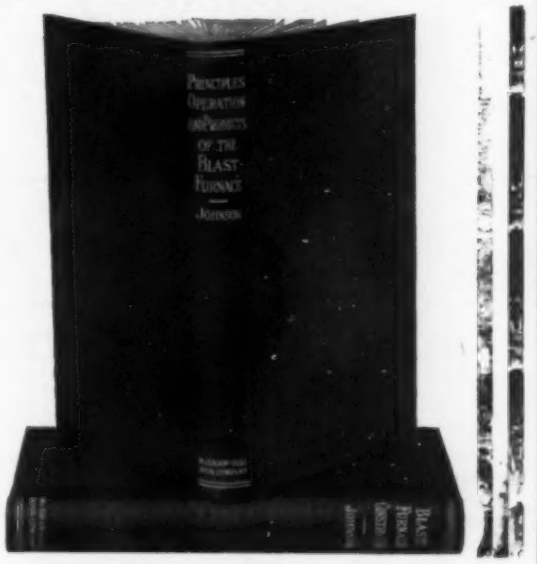
Laboratories and Works: Dayton, Ohio

Electrolabs

General Offices: 15 William Street, New York

Second Installation of 200 Cells for Above Company

Johnson Finishes His Great Work on the Blast Furnace



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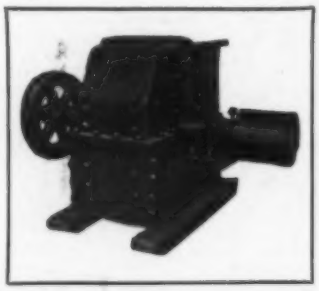
and Durability



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Because:—

Its rugged, all-steel construction withstands the most severe service.
Its manganese steel linings protect all parts from wear.
Its adjustable U-type manganese steel hammers insure a uniform product, with high capacity—and low power consumption.

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K-B Pulverizer Company, Inc.
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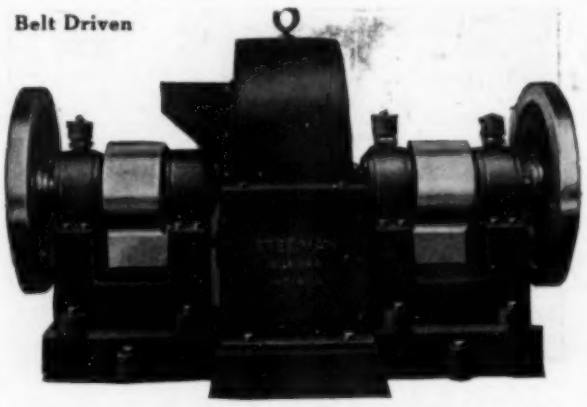
Belt Driven



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They are of the cage type, with cages revolving in opposite directions, and their entire practicability for pulverizing to the desired degree of fineness has been often demonstrated by users who have operated other types of pulverizing and grinding machines.

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Aurora, Indiana

Mechanically Operated Gas Producers —up to two tons per hour capacity.

Autoclaves—Evaporating Apparatus—Multiple Effects—Centrifugal Pumps.

Theisen Washers for cleaning furnace gas.
Gas Holders—Purifiers—Washers—Scrubbers.

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Camden, New Jersey
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Steere Engineering Company
Artificial Gas Engineers and Contractors
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are the simplest, least expensive, and most satisfactory producers for furnace work. Built in Mechanical and Semi-mechanical Types.

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SMITH SECTIONAL GAS PRODUCERS
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High in quality and uniform in heating value.

The Smith System produces a tar-free gas—a clean fuel for particular manufacturing processes.

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Using Bituminous and Anthracite Coals
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is the highest class gas producer built in the U. S. and is advertised in the 1st of the month issues of this journal.

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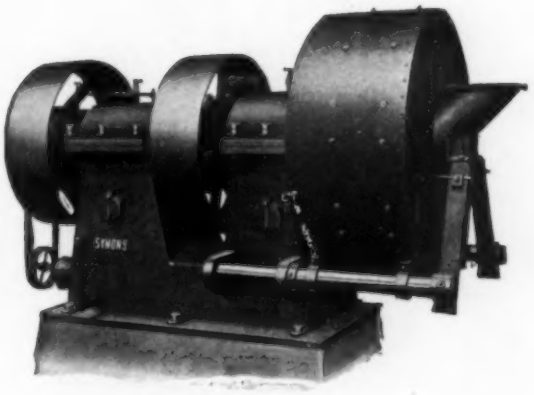
Results obtained by a

Symons Disc Crusher 48"

crushing copper ore

Moisture	3.5%
In operation	2 yrs.—16 hrs. per day
Feed	3"
Product	1"
H. P. used	45
Capacity	115 Tons per hr.
Tons crushed per set discs	220,800 Tons
Average cost for repairs per ton crushed	$0.0107

Extract from report submitted.



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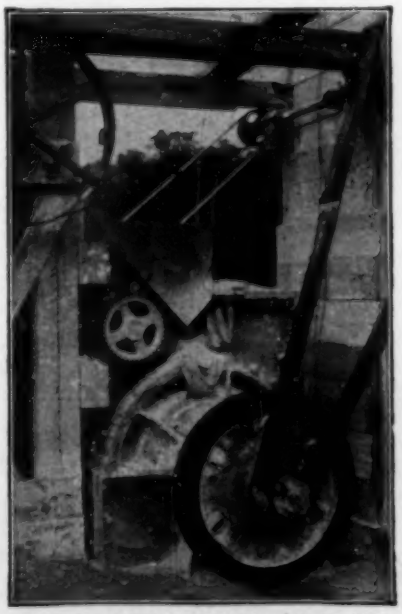
Crush everything that's crushable with the

American Ring Pulverizer



10 ton wet limestone grinding plant. Cost per ton 10 to 15c. for ⅛" product, including labor, power, wear and tear.

Wet or dry materials that are reducible by rolling or pounding can be successfully, rapidly and cheaply crushed to desired meshes on the AMERICAN.

Especially effective on 80% Ferro Manganese. Use it for shale, kaolin, coke, coal, lime, limestone, gypsum, sandstone, gravel, brickbats, quartz, pyrites, phosphate rock, oyster shells, slag, electrodes, ore, feldspar, etc.

Fine Grinding of Wet or Dry Material

Easily erected and repaired. All wearing parts quickly accessible, and can be rapidly exchanged.

Effective at comparatively low speed, and small horse power required. Made in six sizes, from small to large capacity. **Catalog on request.**

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We Crush Everything! Why Can't You Do It!

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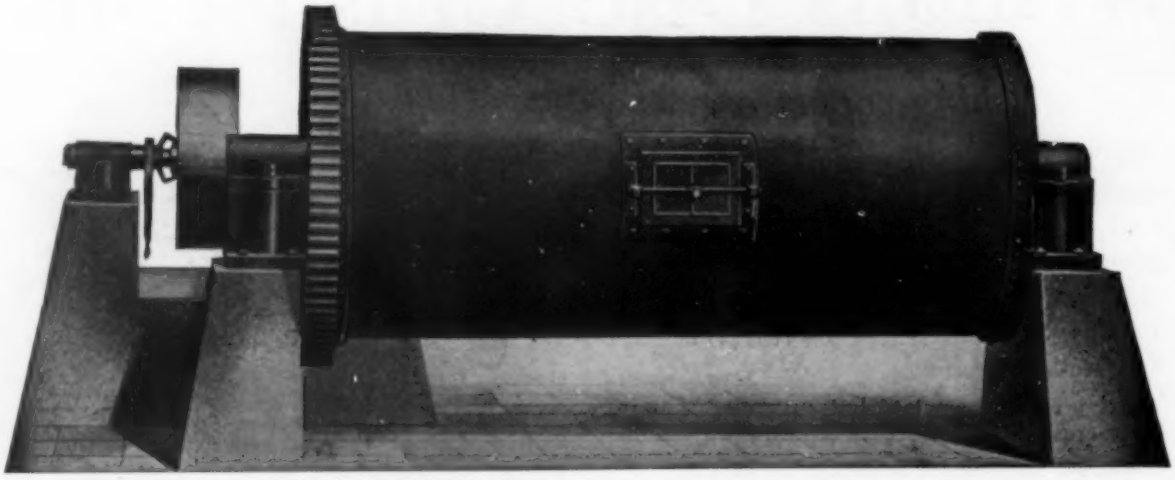
Patterson Continuous Feed and Discharge Tube Mills

All sizes 4′x10′ to 6′x30′. All sizes equipt with Patterson Rapid Discharge Device



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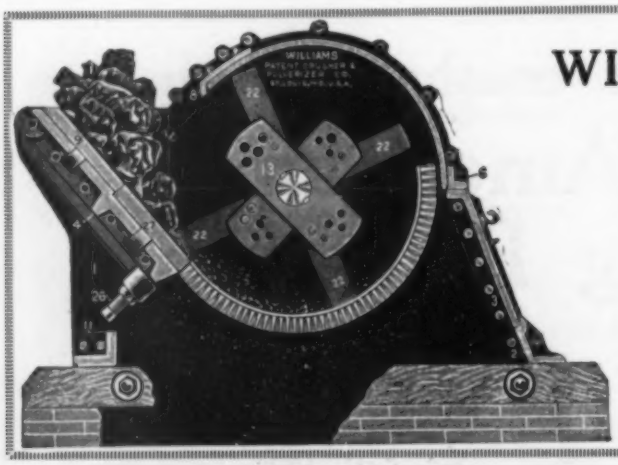
The Patterson Foundry Machine Co.

Builders of Satisfactory Machines

East Liverpool, Ohio



WILLIAMS COAL CRUSHERS

Users of Chain Grates and Stokers can burn Run of Mine and Lump Coal with excellent results, if first crushed with Williams Coal Crushers. Chain grates and stokers for best results must be supplied with sized coal. Sized coal, however, is scarce; the price of sized coal also is higher than for run-of-mine. The solution to this difficult problem, therefore, is crushing of the run-of-mine in Williams Crushers. Williams Crushers will produce ideal stoker coal *with the minimum of degradation*. Williams Crushers are in use in some of the foremost industrial plants in this country, evidence enough of their merits. Complete details in Bulletin No. 18-35.

THE WILLIAMS PATENT CRUSHER & PULVERIZER CO.

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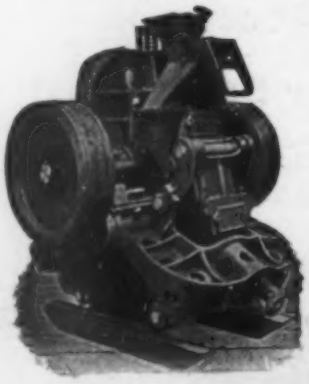
Plant—St. Louis **67 Second St., San Francisco**



Many Metallurgical and Chemical Processes require that the ingredients be pulverized.

THE MAXECON MILL

has been perfected to give the greatest output with least power and wear of any pulverizer even on the hardest and toughest materials.

Uniformly satisfactory results are evidenced when companies such as The Aluminum Ore Co., U. S. Steel Corporation, Pennsylvania Salt Mfg. Co., et al., use The Maxecon as their standard grinder.

We will appreciate the opportunity to help solve your grinding problems either on Coal, Bauxite, Limestone, Silica, Clinker, Phosphate Rock, Hard Ores or other materials.

KENT MILL CO., 10 Rapelyea St., Brooklyn, N. Y.

We make
Pebble Mills,
Ball Mills,
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Vacuum Pumps,
Pressure Blowers,
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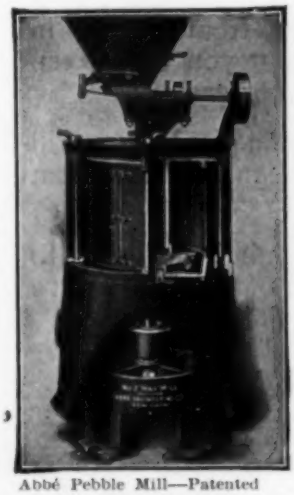
ABBÉ Engineering Co. REDUCTION MACHINERY



Abbé Pebble Mill—Patented

Combination Laboratory Mill

You can very likely select a machine from our 59 sizes and 30 designs to suit your purpose.

We will design and build one for you if you do not find what you want in our standard patterns.

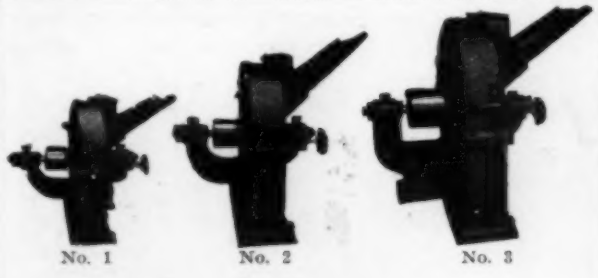
Adaptations of the latter are often made to advantage.

Thirty patents on pulverizing and grinding machinery controlled by us assures that *individuality* and *distinction* that has made Abbé Engineering products famous as the kind that *gets results.*

In our Testing Laboratories we make no charge for grinding, crushing, cutting or mixing samples and submitting full reports on suitable machines to do the work. Kindly pay shipping charges on samples.

Abbe Engineering Co.

218-220 Broadway, New York
Tel. No., Cortlandt 54, 55, 56



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World Beaters!

for economically grinding and pulverizing a great variety of materials, such as:

Dry Colors	*Asphaltum*
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Chemicals	*Drugs*
Asbestos	*Caustic Soda*
Lime	*Carbon*

MEAD MILLS

Clay	*Magnesia*
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Factory and Office:
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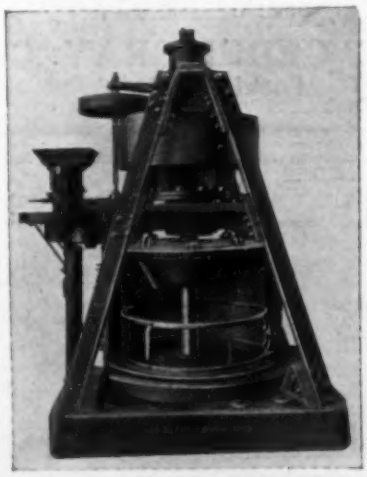
The Improved Giant Griffin Mill

For very Fine Grinding of Refractory Materials.

A self-contained unit for Pulverizing Coal, Coke, Limestone, Alunite, Dry Chemicals, Cement, Phosphate Rock, etc., where a finely ground finished product is required.



BRADLEY PULVERIZER CO.

Boston **Works: Allentown, Pa.**

TRAMP IRON

Keep it out of your Crusher

Your crusher wasn't made for bolts, nuts, spikes, sledge heads coupling pins, etc. You can't keep this tramp iron from getting in your material but you CAN keep it out of your crusher.

The Dings Magnetic Pulley will prevent any foreign substance from getting into your crusher feed.

Make up your mind right now to avoid any more of those expensive shutdowns.

We'll send details gladly.

Dings Magnetic Separator Co.
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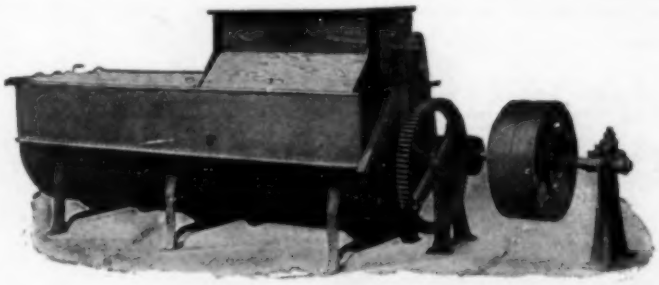
For Wet and Dry Materials

Hot or cold, coarse or fine materials can be thoroughly and economically mixed in the various types of Gardner mixers.

No matter what your sifting or mixing problems may be, we have the machine to handle them.

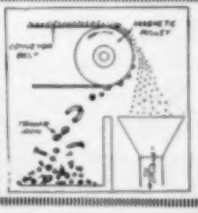
Catalog on request.
Shall we send one?

THE GEDGE-GRAY CO.
Lockland, Ohio



A Gardner Combined Sifter and Mixer for dry materials. Capacity 1000 to 4000 lb. at one charge. Used for sifting and mixing all kinds of powdered and granulated materials made in chemical and allied industries.

Buchanan Magnetic Separators
(Seven Distinct Types)
Crushers
Crushing Plants complete in all details
C. G. BUCHANAN CO., Inc.
90 West Street **New York**



Use M-M-C MAGNETIC PULLEYS
to insure your Crushers and Grinders against damage from tramp iron, etc.
We build a full line of Magnetic Separators of most modern design. Write for bulletins and estimates.
MAGNETIC MANUFACTURING CO.
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C-H Magnetic Separators

What they are used for in 35 different industries—explained in new Booklet S.

The Cutler-Hammer Mfg. Co., Milwaukee

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"Concentrations and separations of ores effected by utilising the differences in electrical conductivity of the particles of which ores are comprised, without water or roasting, regardless of specific gravity or magnetic quality, making separations and recoveries never before commercially attainable."

Electrostatic Separation should be carefully and thoroughly investigated by every one at all interested in the concentration or separation of ores, whether the ores are simple, complex, or refractory.

The General Manager telegraphs the President without grief or disappointment:

La Salle, No. 1249 W. 6th St., Los Angeles, Cal.—"Making concentrates to beat the band. First shipment almost ready."

G. E. McCORMICK, Ameca, Jalisco, Mex.

At a well known Mexico copper property, the concentrating of the ores is done entirely by flotation, and K & K Flotation Machines are used exclusively.

None of the usual grief and disappointment incident to starting up a new mill was experienced at this plant, and the General Manager telegraphed the President as above.

The reason you should consider K & K Flotation Machines for your operation is that they will duplicate the best work of other type flotation apparatus continuously and without loss of efficiency AT LESS COST.

In more than one instance K & K Flotation Machines have turned flotation failures into successful operations.

The thorough aeration of the flotation pulp is the most important factor to successful flotation.

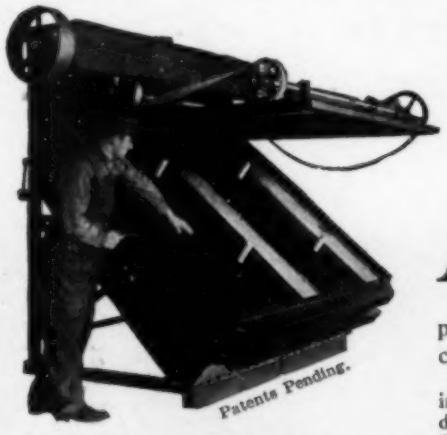
Investigate the K & K way, and you will see how the machine accomplishes it.

The K & K Flotation Machine

Southwestern Engineering Company, Inc.
523-25 Wesley Roberts Bldg., Los Angeles, Cal.

The New Wood Machine

The "Keystone" of Vibrating Screens



A TAUT screening surface at "drumhead" tension is the keystone of an efficient vibrated screen around which everything else must be built.

Without a taut screening surface, effective vibration is impossible and the maximum tonnage and thorough separation cannot be obtained.

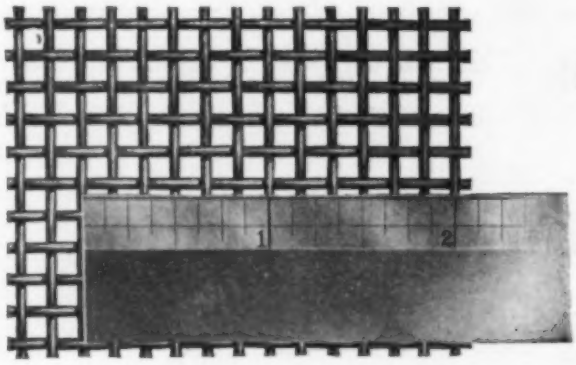
In the WHIP-TAP Separator, no tacks, bolts or rivets are used in attaching the wire cloth to the screen frame—as shown in above drawing, every wire of the screening surface is turned over and firmly clamped into a metal edge which hooks over the frame; and, when the tension is applied by turning the stretcher bars (of which there are three) with the key, the frame expands and every individual wire is stretched taut.

WHIP-TAP screen cloths are always operated at drumhead tension; every wire is vibrated; the material is spread over the entire screen; and the maximum tonnage of closely sized product is produced.

WHIP-TAP
Separator Screen
SCREENS ANY DRY MATERIAL
WRITE FOR PARTICULARS

THE W. S. TYLER COMPANY

Manufacturers of TYLER "Double Crimped" Wire Cloth and Mining Screen. **CLEVELAND, OHIO**



"Perfect"

Double Crimped Screens Always Stand This Test

"Perfect" Double Crimped Wire Cloth is accurately made. Strict adherence to standard wire gauges is our practice, and every precaution is taken to insure uniformity of mesh.

Take any "Perfect" screen, lay a ruler on it at random at any place on its surface and you will find that the mesh count will tally exactly with the specifications of the screen. For example, if you order a 16-mesh screen you can be certain that every square inch of its surface will count 16 *uniform mesh* both ways.

And what is more, the mesh of "Perfect" screens stay uniform during their service life. The double crimp construction insures that.

Made in All Sizes for Every Screening Purpose

Write for our "Perfect" Screen Book.

THE LUDLOW-SAYLOR WIRE CO.

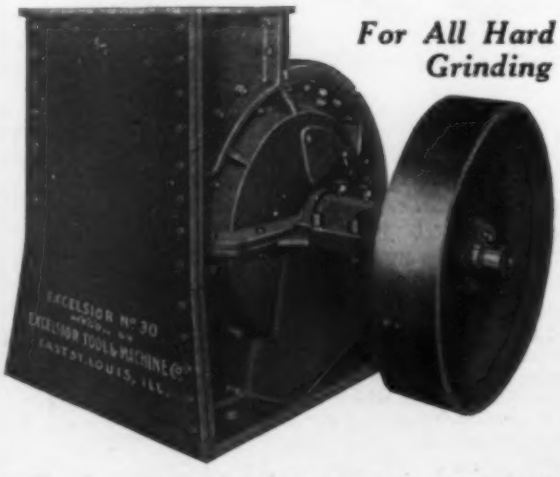
General Office and Factory, St. Louis, Mo.

Branch Offices: 10 East Jackson St., Chicago Mills Building, El Paso, Texas Felt Building, Salt Lake City, Utah

Excelsior

Ring-Roll Pulverizer

For All Hard Grinding



These advantages include the grinding of hard materials to *any desired mesh* at low speed, and free grinding tests to show what it will do with your material. **Send Samples.**

The Excelsior is made in five sizes, and is designed to satisfactorily do the great majority of work within its wide field. Prompt deliveries.

Send for circular.

Excelsior Tool & Machine Company

East St. Louis, Ill.

Capacity - - - - - +
Floor Space - - - - - —
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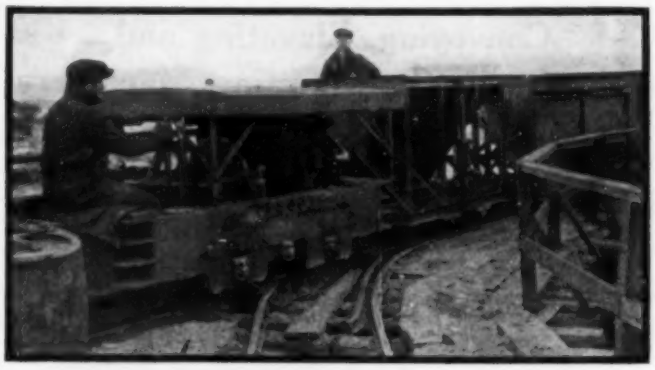
"Vesuvius"

Sulphur Burner

Will completely burn any amount of sulphur, depending upon the size of Burner. No sublimation, no dirty fires, no frequent cleaning. All sediment drops to bottom compartment and is easily removed. Determination of quality of gas is readily made without scientific testing instruments. Get specific details.

Valley Iron Works Co.

Appleton, Wis.



They're Working Double Shift—But the PLYMOUTH Hasn't Discovered It!

IN the busy season, The Loretto Iron Co., Loretto, Mich., run in two shifts, and, upon purchasing a PLYMOUTH Gasoline Locomotive a couple of years ago, they put it on 16-hour schedule.

After what they considered a reasonable time, they ordered some repairs and looked for a place to put them—but the joke was on the owners, for the PLYMOUTH was still tuned right up to High C, running as it did the first day!

PLYMOUTH Locomotive Handles Load Without Effort—Customer Sends Repeat Order

Though the average load is light—well within the Locomotive's capacity—and the haul not extra long, the Loretto Iron Company has had an excellent chance to test out the PLYMOUTH.

PLYMOUTHS a Proved Success in Mine Hauling; Let Us Tell You About Them

The PLYMOUTH Gasoline Locomotive has been in successful use for years, and hundreds are in practical, profitable, everyday work in nearly every kind of hauling, all over Industrial America.

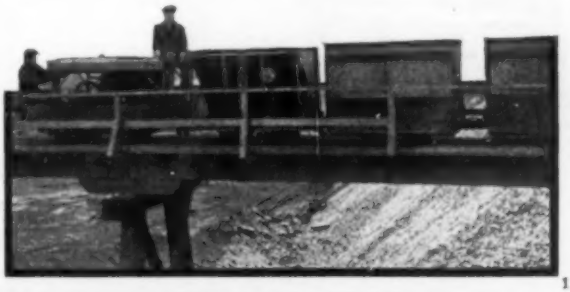
Included among our customers are many big mining companies, who gladly testify to the good work PLYMOUTHS have done for them. Tell us the conditions under which your hauling is done, and we'll gladly send you interesting details—without obligating you in any way.

THE J. D. FATE COMPANY

214 Riggs Avenue PLYMOUTH, OHIO

Sales Representatives in all Principal Districts

And their decision to order another, not long ago, shows what they think of it. A repeat order, we feel, is the best recommendation a customer can give.



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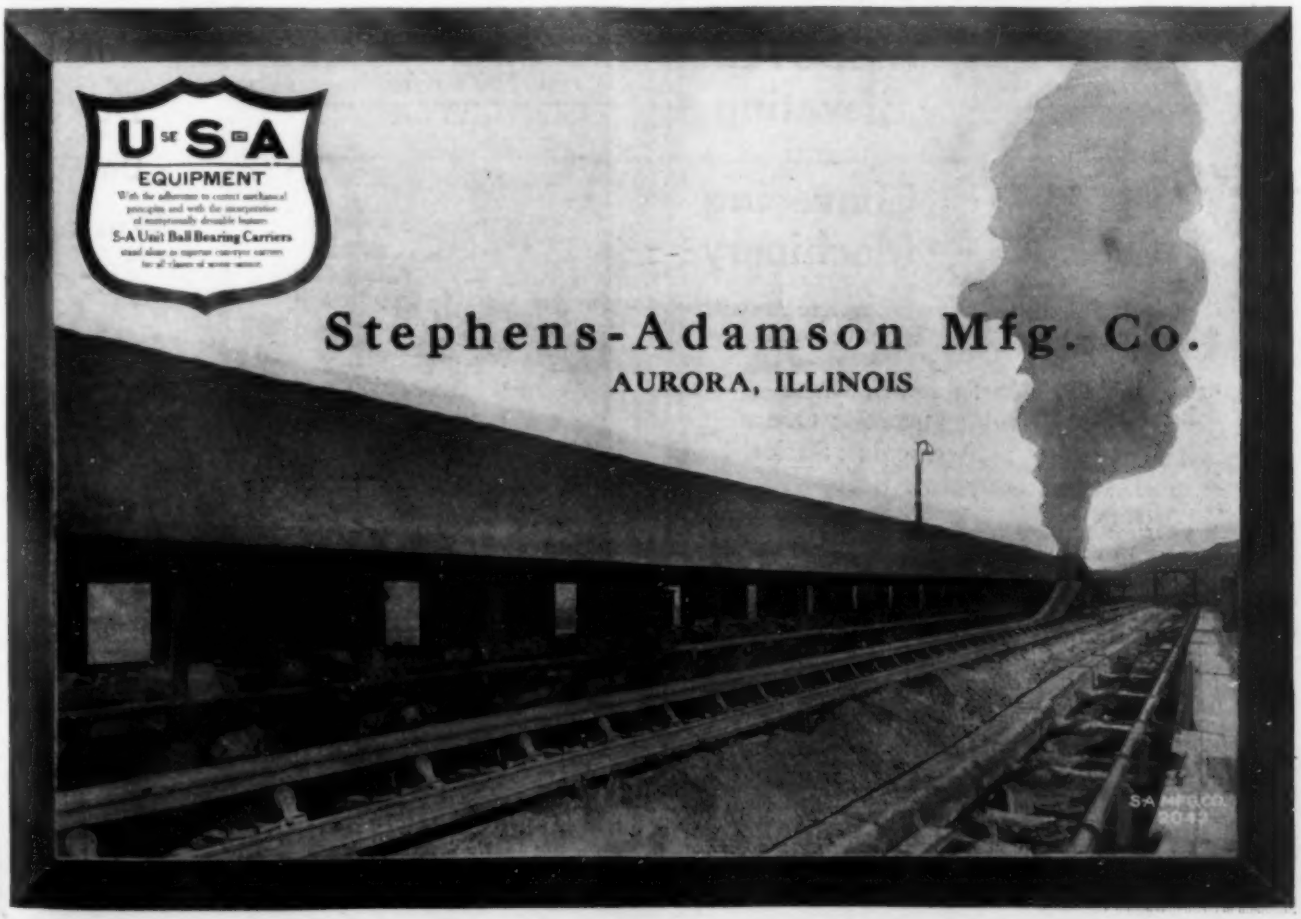

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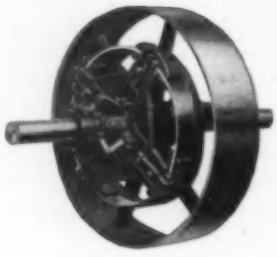

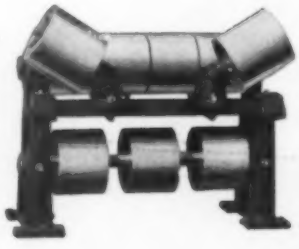

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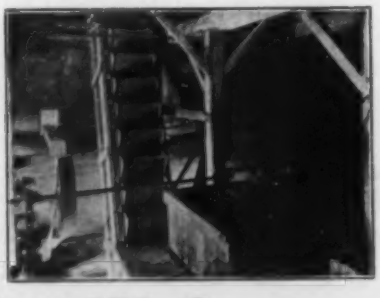

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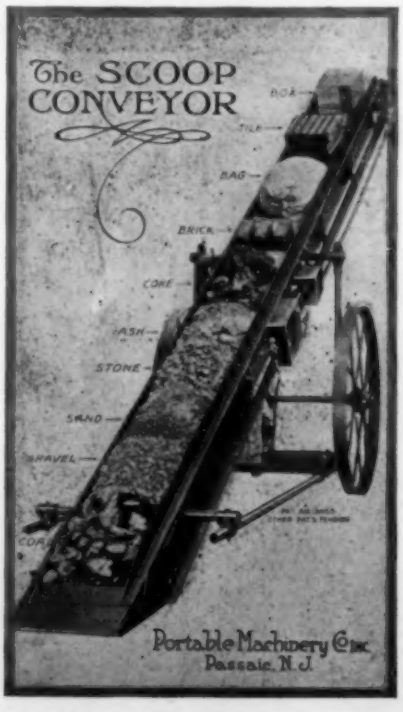

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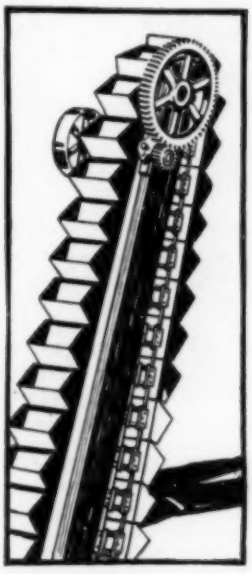

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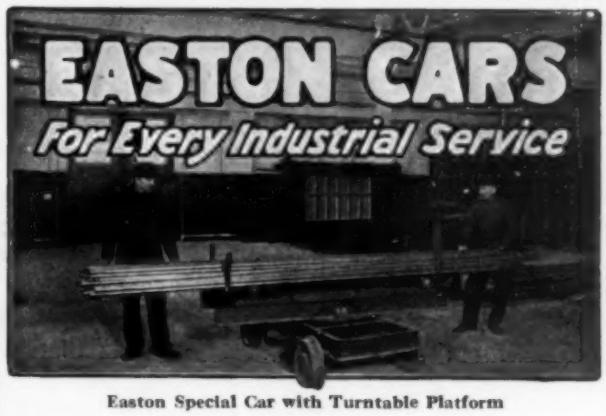

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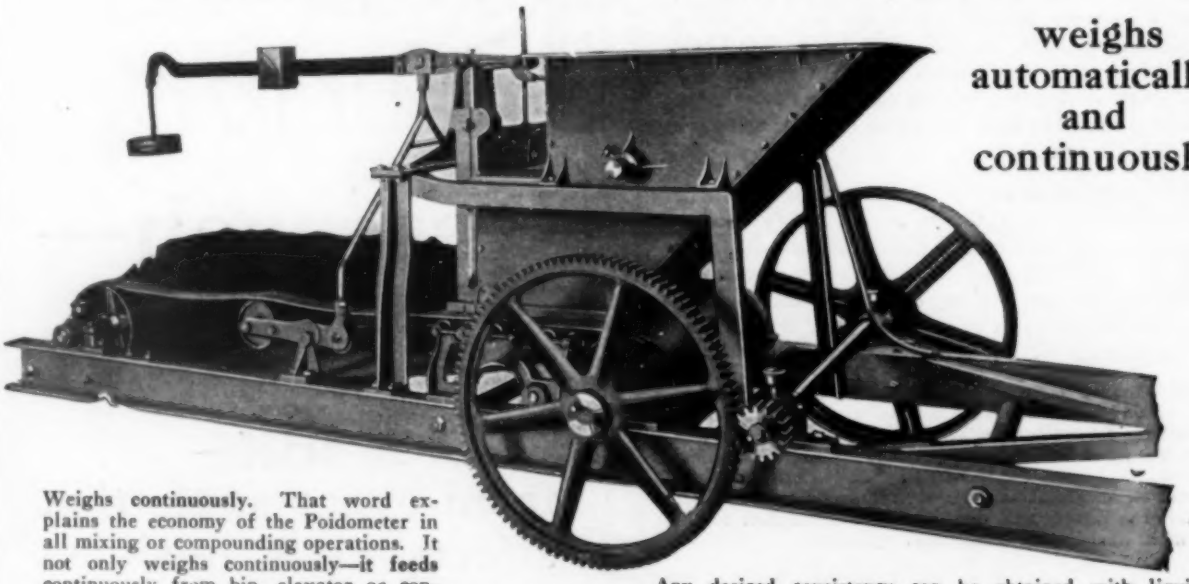

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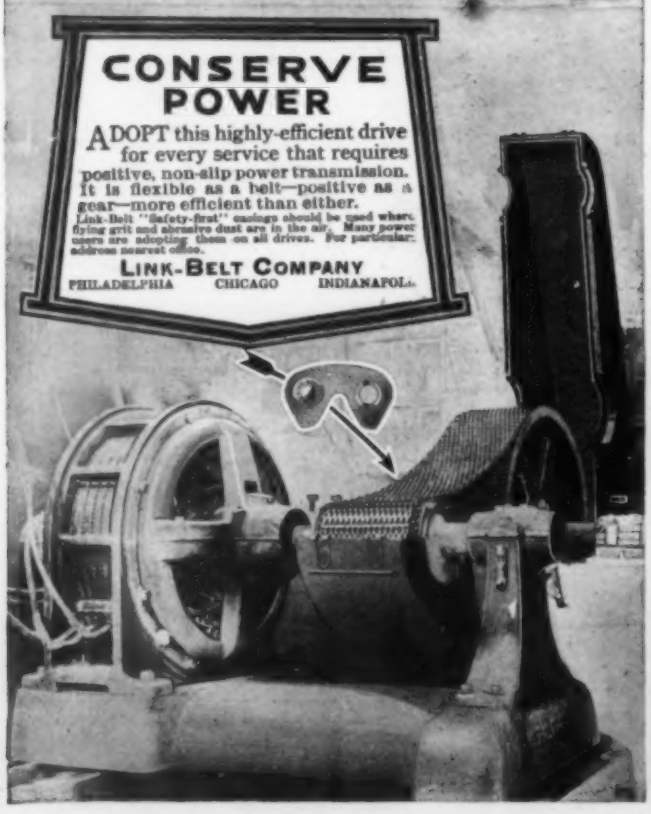
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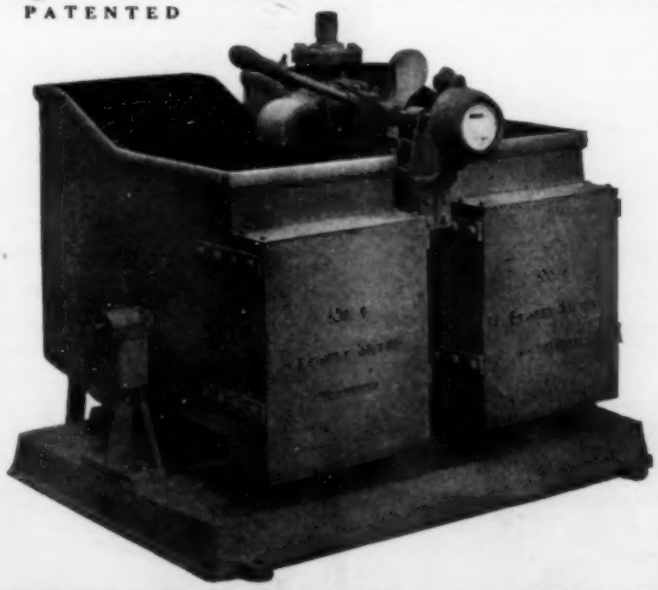

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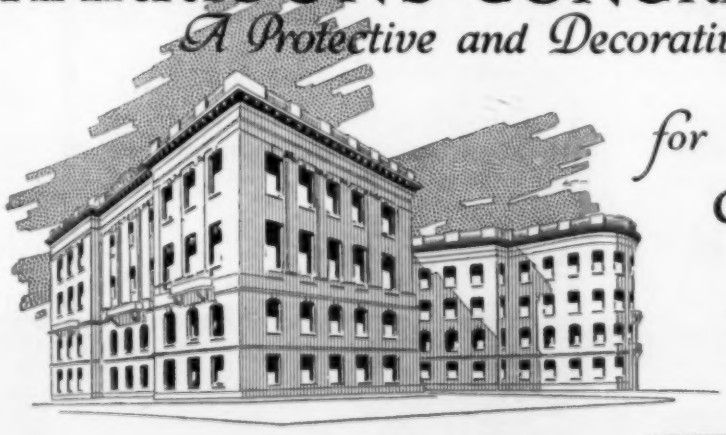

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This central jet

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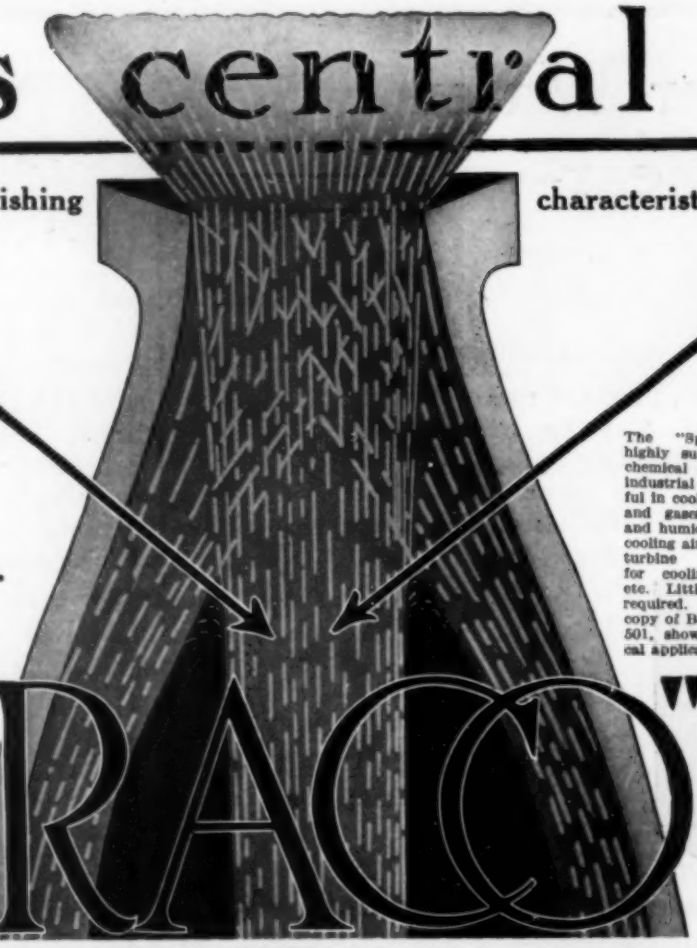

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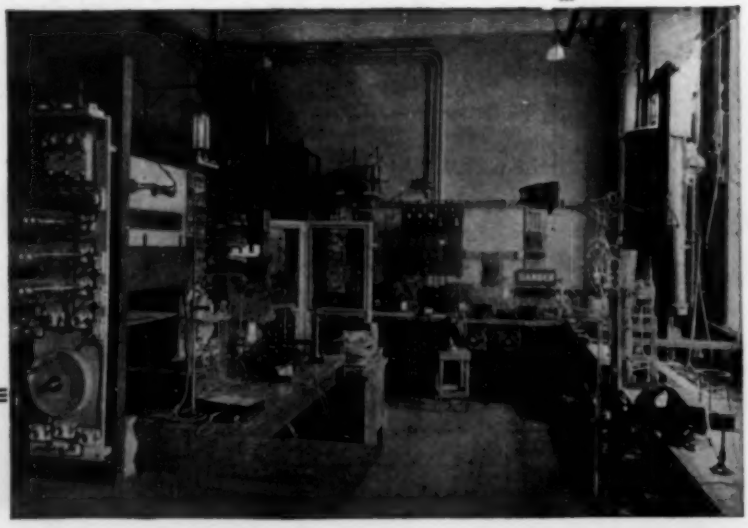

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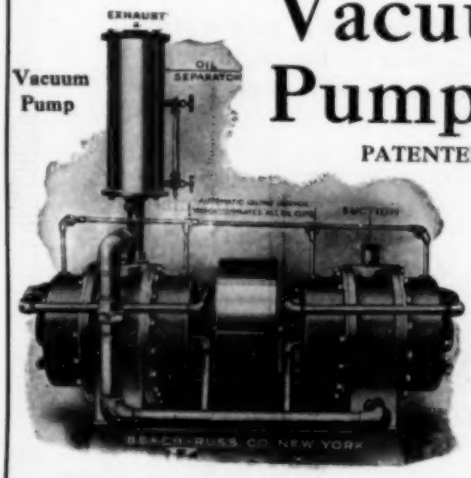
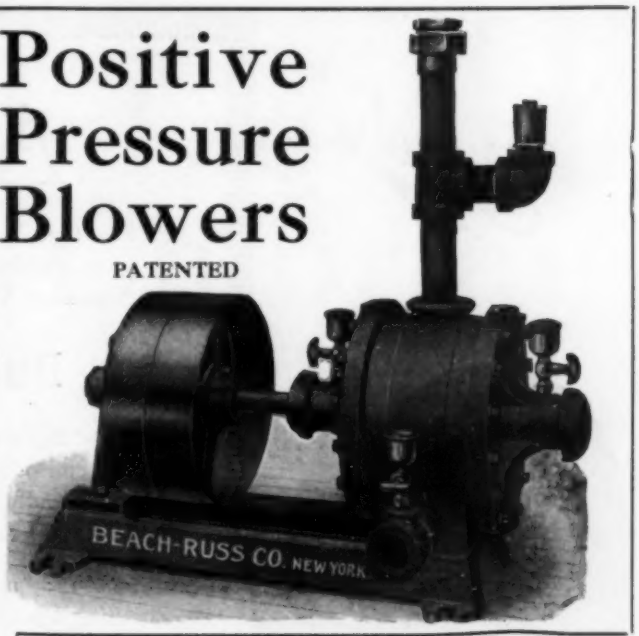
PATENTED



Positive Pressure Blowers
PATENTED



Blowers will give a steady supply of air without a receiving tank. No pulsation. Pressure may be regulated between 1 and 12 lb. Direct motor drive if desired. We have thousands in use all over the country.

Beach-Russ Company
Manufacturers
220 Broadway, New York
Phone Cortlandt 55

The Simplest Air Compressor and Vacuum Pump
NASH HYDROTURBINE

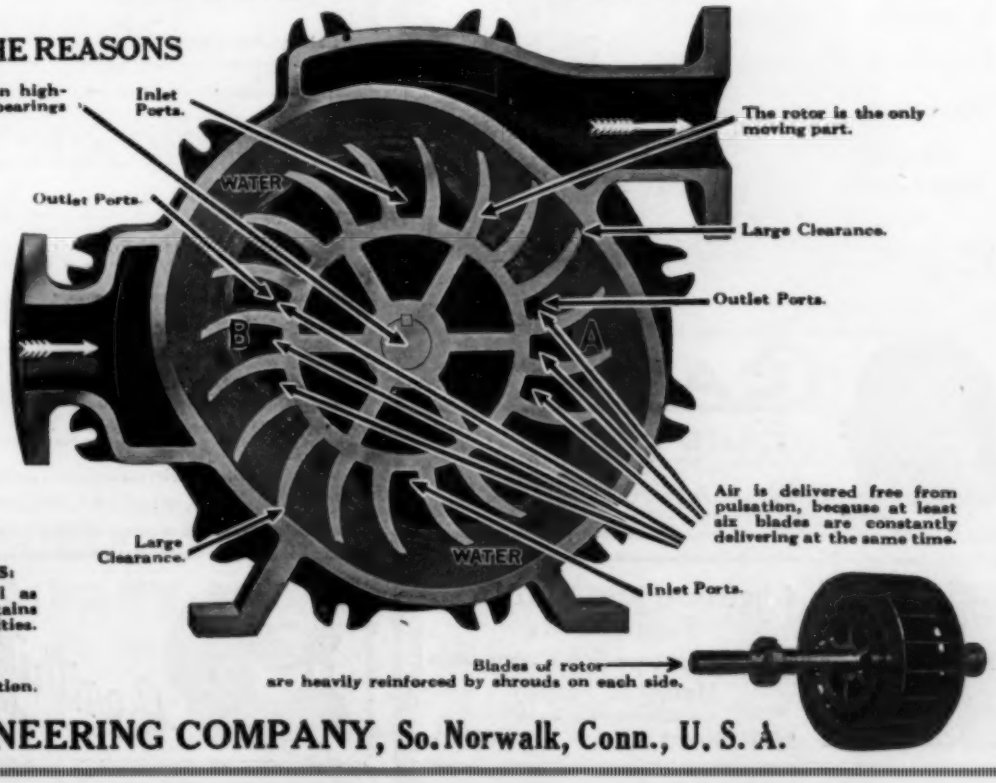
HERE ARE THE REASONS

Shaft is mounted on high-grade annular ball bearings outside of casing.

Note the total absence of valves, pistons, piston rods, crank shafts, loose vanes and gears.

Side thrust is eliminated because compression takes place simultaneously on opposite sides of the rotor (at A and B).

CHARACTERISTICS:
Air is washed as well as compressed, and contains no oil or other impurities.
Absolute Reliability
High Efficiency.
Delivery without pulsation.


Inlet Ports.
The rotor is the only moving part.
WATER
Outlet Ports.
Large Clearance.
Outlet Ports.
B
A
Air is delivered free from pulsation, because at least six blades are constantly delivering at the same time.
Large Clearance.
WATER
Inlet Ports.
Blades of rotor are heavily reinforced by shrouds on each side.

NASH ENGINEERING COMPANY, So. Norwalk, Conn., U. S. A.

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Acid Fans

Our long experience in building acid fans and blowers enables us to build the type of equipment best suited to meet YOUR requirements.

Built of Any Material

"Buffalo" Acid Fans and Blowers can be built of any metal or alloy that is most suitable for the special work demanded of them—cast iron, lead, bronze, monel metal, copper, tin or aluminum.

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Write to Dept. 55.

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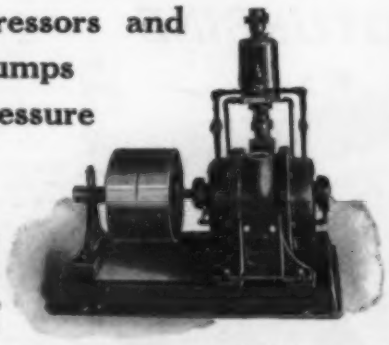
CROWELL

Air Compressors and Vacuum Pumps
Positive Pressure Blowers



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Blowers, Gas Pumps, Water, Vacuum and Liquor Pumps.

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The most widely used Sand Pump

Its special chilled car-wheel iron liners and moderate speed reduce costs and save trouble. Send for the Krogh Sand Pump Bulletin.

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Acid-Proof Centrifugal Pumps

Volute made of chemical stoneware. Impeller and stuffing box acid-proof. Strong construction, built for continuous operation.
Sizes: 1 to 3-in. discharge.

Write for full information, prices and guarantee.

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Chemical and Industrial Equipment

Rapid Delivery — Fine Workmanship

Henry E. Jacoby
Contracting Engineer
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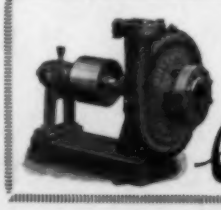

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We specialize on single stage low head centrifugal pumps.
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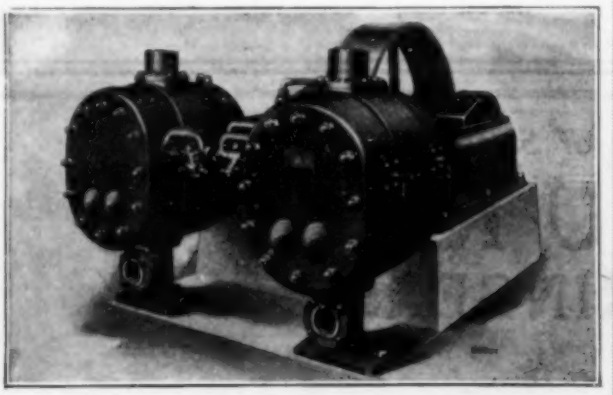
VACUUM PUMPING COSTS

In vacuum pumping the cost of attendance is a factor of importance as well as the power cost. With a machine of the open type frequent attention is necessary to supply the many oil cups with lubricant.

INGERSOLL-RAND VACUUM PUMPS wipe out this expense. All principal bearings are flood lubricated and cylinders force feed oiled. Then, too, the saving in the cost of lubricant is a valuable one.



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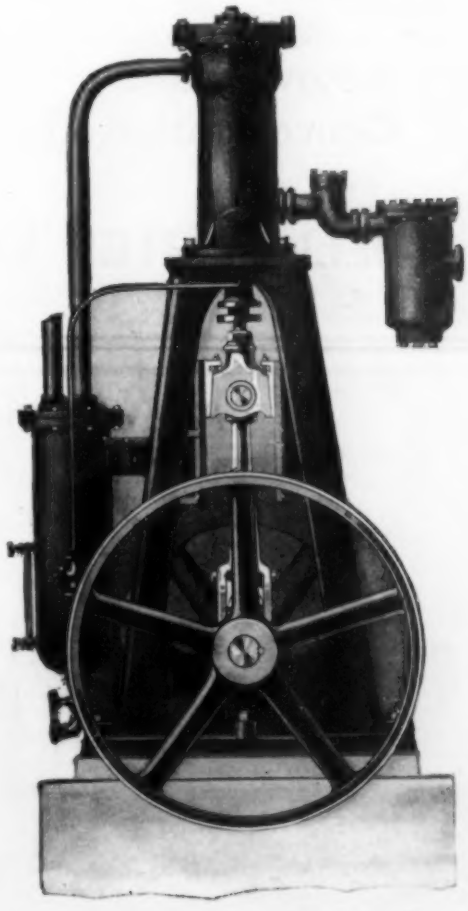
Investigate Improved Hercules Liquid Sealed Chlorine Compressor

We are in position *to show* a complete Liquefying Plant. Hercules Liquefying Process Represents Highest Development in the Art



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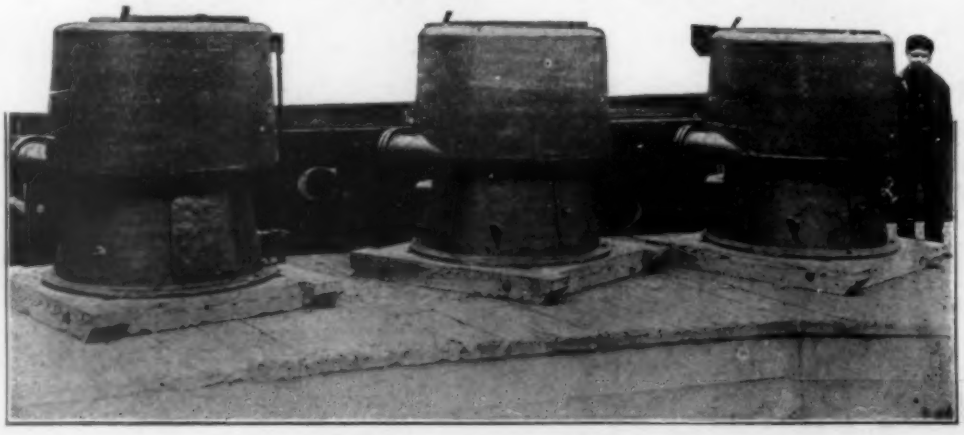

now in daily use in one of the largest nitro-cellulose manufacturing plants in this country.

This type of acid wringer is the latest design and has proven to be the most economical and efficient centrifugal for the treatment of nitro-cellulose.

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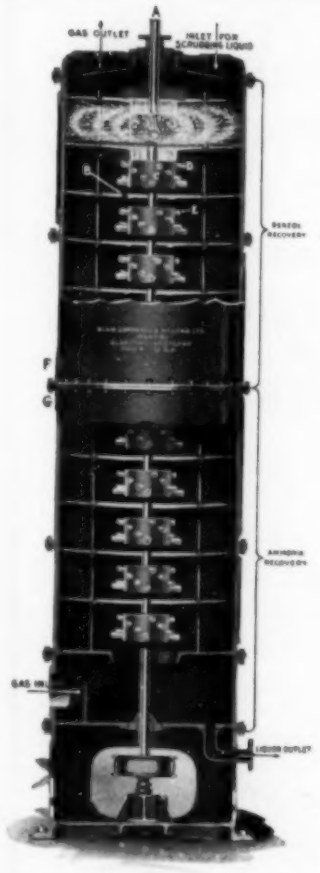

To Increase Benzene and Toluene Production

Use "MacLaurin" Patent Centrifugal Gas Scrubbers. The Most Efficient Scrubbers Ever Offered.

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Equipment includes Patent Centrifugal Gas Scrubbers, Continuous Separating Stills with Superheaters, etc., Continuous and Discontinuous Purifying Stills, with Patent *Horizontal Dephlegmators,* Preheaters, Oil Coolers, etc.

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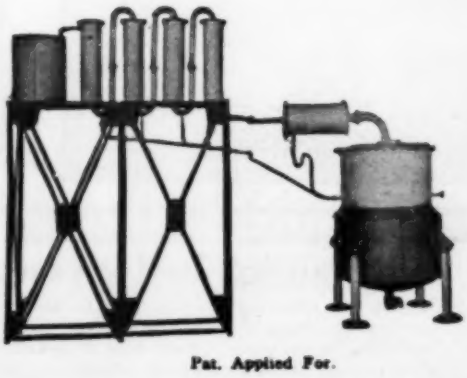

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Rectifying Apparatus for All Purposes

What a saving the re-use of your alcohol or other solvents would be! Now, how to get it.

If They Are in Excess in Solids, Evaporate and Then Condense Them

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Either type of apparatus, or both, can be supplied to you by us, promptly.

Our Rectifying and Fractionating Apparatus is low and can be installed within the height of an ordinary room

We can take care of small or large quantities

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Resines
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No Choking
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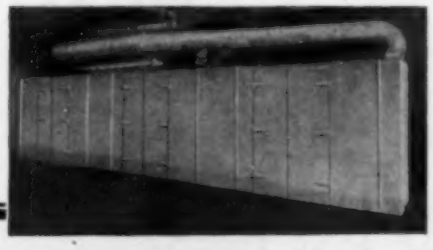
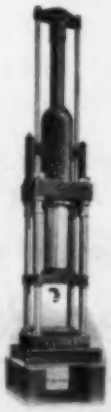
Warm Moist Air
Dryers





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If you are adapting your factory to assist in meeting the demand for munitions you may be interested in the standardized line of hydraulic shell making presses we are building.

These include forging and drawing presses for the billet piercing and drawing operations, presses for the boxing and banding operations and hydraulic shell testing presses.

Interested parties should write for our illustrated descriptive literature.

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COLORS
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By drying at great speed, low cost and with absolute uniformity Gordon Dryers have proved their marked superiority.

Your requirements can be filled by one of our numerous types of Apparatus.

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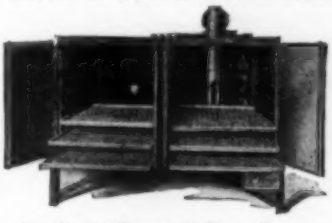
Chemicals, Paint Colors, Aniline Dyes, Dry Colors for Printers' Inks, Lithopone, White Lead and Similar Materials.

Installing a machine to do a certain amount of work is one thing—But installing a machine and guaranteeing that it will do just that amount of work or more is another.



Smallest "Proctor" Tray Dryer for Chemicals, etc.

Every "Proctor" dryer is sold with an absolute guarantee that it will do all we claim for it.

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Chicago, Ill.
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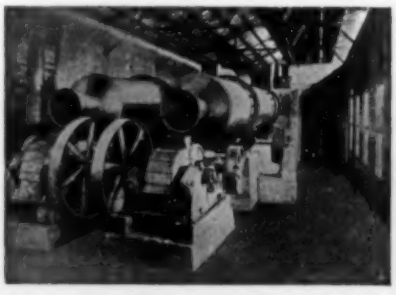

One Ruggles-Coles Dryer Sells Another

During 1916 the percentage of repeat orders for Ruggles-Coles Dryers was over 35 per cent. of our total sales.

The past year 45 per cent. of our business was on re-orders.

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50 Church St., New York 322 S. Michigan Ave., Chicago
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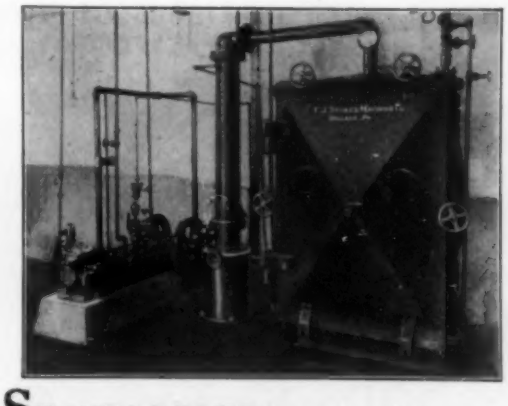

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Tell us your drying problems

Old methods superseded

Keep drying costs down

Easy to operate

Solvents reclaimed

F. J. Stokes Machine Co.
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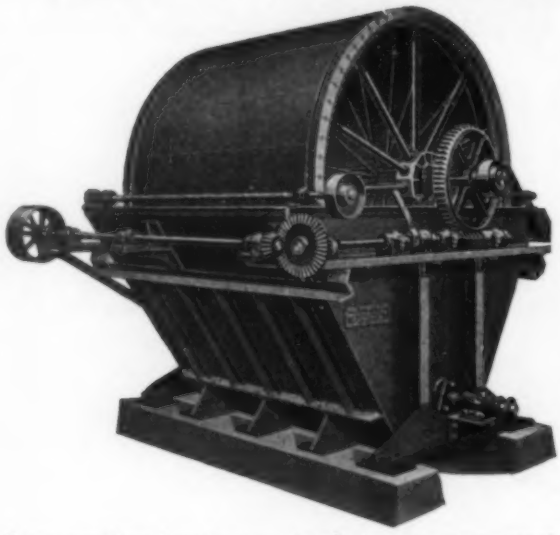

has solved the filtration problem at many plants. It handles a wide variety of materials on the large scale, continuously and automatically without attendance and at phenomenally low operating cost. If you have a filtration problem of any nature whatever it will pay you to investigate the Portland, as there are comparatively few conditions it cannot meet.

No other filter can do as much—

Some machines have one or two features to recommend them. But it is the all'round combination of desirable features—found in no other type of filter or dewatering device—which makes the Portland so desirable. It is absolutely automatic, runs without any attendance whatever. The operation is continuous, not intermittent. The dry discharge, to as low as 8 and 9%, cannot be surpassed, rarely equaled. It is easily set up. Repairs are infrequent and, when necessary, cheaply and easily made. Power consumption is low.

Pamphlet 28-C describes it and is worth sending for.

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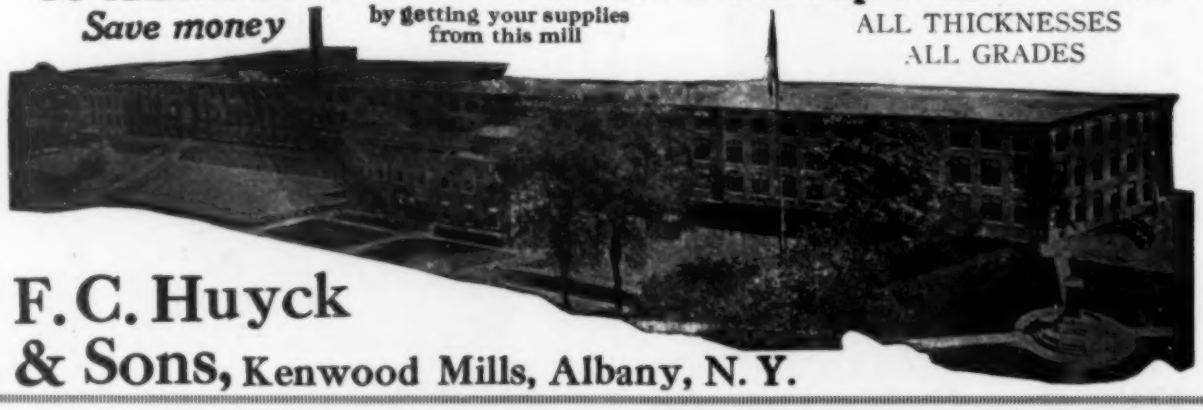
To American Users of Filter Cloths and Paper Makers' Felts

Save money **by getting your supplies from this mill**

ALL THICKNESSES
ALL GRADES



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THE "JOHNSON" FILTER PRESS

Backed by 38 years' experience

Over 15,000 in use

JOHN JOHNSON COMPANY

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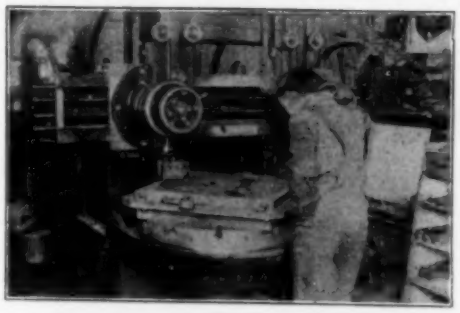
WE ARE FILTRATION ENGINEERS



A quality product all the way through

from raw material, through the various processes of designing, casting, machining, hand finishing and inspection.

SPERRY FILTER PRESSES

There are a thousand ways for a filter press to go wrong in the making, but only one way for it to go right, and that way is the Sperry way of exercising the utmost vigilance at every step. Sperry Presses are chosen by leaders in every industry where that type of press is used.

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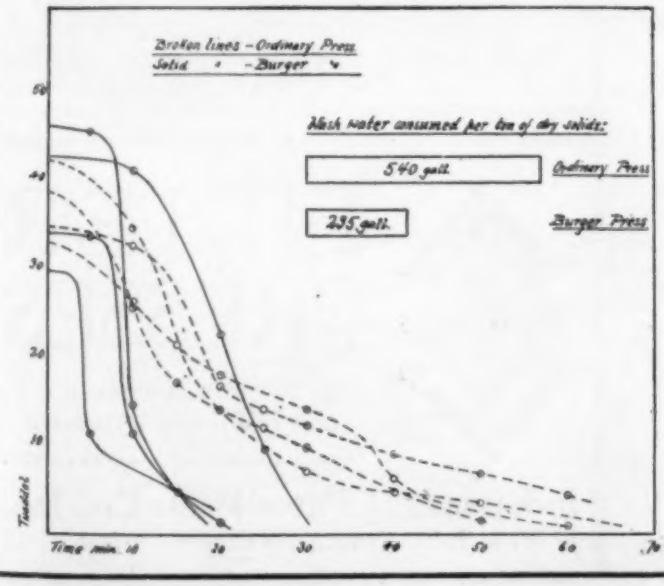
SPERRY FILTER PRESSES GIVE SATISFACTION

Some filter-press engineers will tell you it can't be done. It is done in the

Burger Filter Press


Broken lines – Ordinary Press
Solid " – Burger "
Wash water consumed per ton of dry solids:
540 gall. Ordinary Press
235 gall. Burger Press
Time min.

The direct-flow principle of washing (patented).

A *uniform cake*—NOT thicker one place than another. 100 to 600% greater filtering and washing efficiency. Half the wash water.

Decantation, with tanks, large volumes of water, etc., made unnecessary in many cases.

Our literature is an intelligent presentation of facts. Specific questions will be answered by our engineer.

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B & G WIRE PRODUCTS

include cloths, fine or coarse, light or heavy, for every purpose where accuracy is required. Let us send you samples and prices.

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No Limit to Uses for Diamond-Fibre

Diamond-Fibre is a dense, horn-hard material of unique texture, designed to supplant for many purposes, wood, iron, steel, brass, tin, hard rubber, leather and many other scarce and costly materials used in the electrical, automobile and a great variety of other industries.

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A Mark of Quality — A Sign of Service
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FILTER PRESSES

Laboratory Press designed for making practical tests.

We build Iron Plate and Wood Plate Presses in all sizes from 12 to 40 inches.

Write for information and prices

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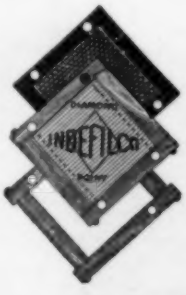

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Filter Leaf Covered with Monel Metal Wire Filter Cloth

Why pay the Labor Costs of changing cotton filter cloths?

MONEL METAL Filter Cloth

needs no attention or replacement

In the saving it makes possible on *reduced labor costs alone* it pays for itself in a short time. Even if this filter cloth were not *acid- and alkali-proof* it would still be your best investment, on account of its *tensile strength* and the perfect filtration results which its special, closely-woven mesh makes possible. Why use cotton and camel's hair when you can get strong, lasting, monel metal? Let our engineers consult with you regarding *your* special problems.

Prompt Delivery. Let us cover your filter leaves

MULTI-METAL Separating Screen Co.
Makers of Screens from 4 to 350 Mesh in All Metals
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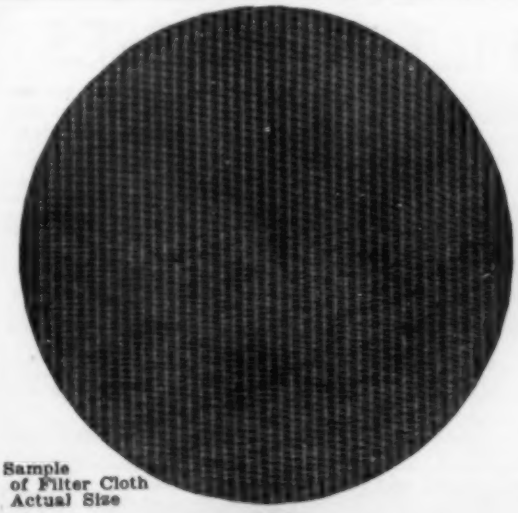
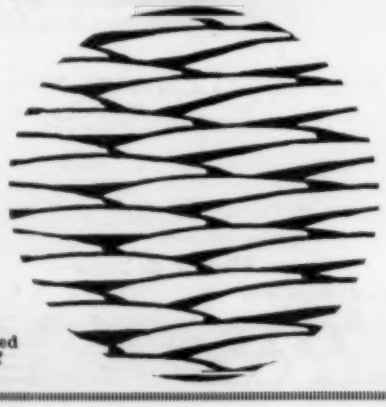


Sample of Filter Cloth Actual Size



Magnified view of Cloth

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Brass—Copper—Phosphor-bronze Monel Metal

Extra fine Phosphor-Bronze Wire Cloth, all meshes, Plain and Twilled Weave.

Special Wire Cloths to Order

Newark Filter Cloth, for all pressure filtration, has double Filtration Surface, is extra strong, rapidly cleansed, made of monel metal. Samples on request.

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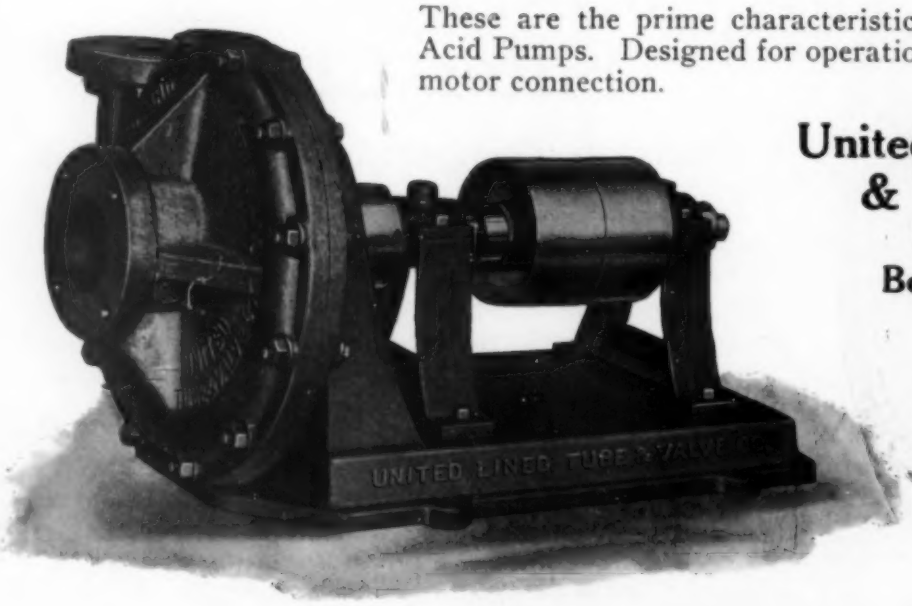
Hard Lead Centrifugal Acid Pumps

Strength—Service—Durability

These are the prime characteristics of our Centrifugal Acid Pumps. Designed for operation by pulleys or direct motor connection.



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Manufacturers

Boston, Mass.

General Selling Agents:

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This still has been investigated and adopted by the leading chemical laboratories, scientific houses, storage battery manufacturers, railroads and many of the world's foremost industrial concerns. It meets the approval of and is in extensive use by U. S. Government laboratories.

Cost Low
High Efficiency

Capacities ½ to 15 gal. per hr. Operated by gas, gasoline, kerosene, steam or electricity.

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The Allbright-Nell Co.

Manufacturers

Chicago, Ill.

Centrifugal Linings and Filter Press Plates

Steel, Copper, Brass, Aluminum, Lead, Zinc, Tin and other metals or materials perforated as required.

Perforated Metals of Every Description

Our catalog sent you on request

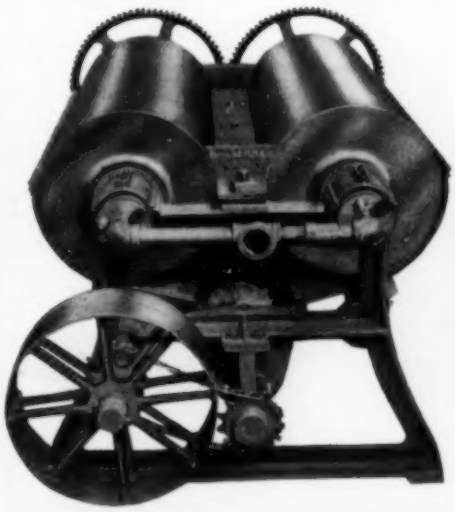
Chas. Mundt & Sons

494 Johnson Ave. Jersey City, N. J.

CHEMICAL COOLING

For Cooling and Flaking Chemicals Use

Brecht Patented Duplex Cooling Cylinder



A constantly revolving large cooling surface.
Capacities from 1000 to 8000 pounds per hour, depending upon temperature of material.
Cooling agent may be either Water, Brine or the Direct Expansion of Ammonia in conjunction with Mechanical Refrigeration.

The Brecht Refrigerating Machines
may assist you further in solving your cooling problems.

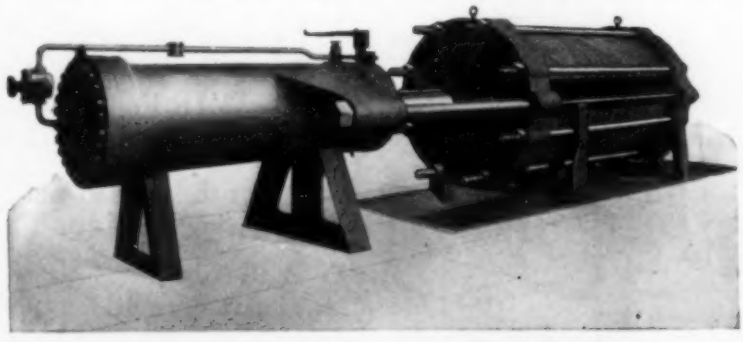
We also manufacture
Cotton Seed Oil and Vegetable Oil Refining Plants—Deodorizers—Compound Lard Plants—Evaporators—Filter Presses—Rendering Tanks and Fertilizer Dryers.

THE BRECHT COMPANY

ESTABLISHED 1853
Exclusive manufacturers of machinery, equipment, tools and supplies pertaining to the meat and allied industries.
Main Offices and Factories:
1246 Cass Avenue, St. Louis, Mo.

NEW YORK 174-176 Pearl St. | CHICAGO 725 Monadnock Bldg. | PARIS 23 Rue de Rocroy | BUENOS AIRES Calle San Martin 201

CARBONDALE MACHINERY



Refrigerating Machines
Liquid Carbonic Acid Gas Plants
Chilling Machines
The Carbondale High Pressure Filter Press
Has flexible plates, offering conspicuous advantages in high pressure work. Use it under pressures of from 300 to 400 pounds.

CARBONDALE MACHINE CO.
General Offices and Works:
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Branches:
New York Philadelphia Chicago Pittsburgh Baltimore New Orleans

THE BAKER COOLER

Applicable to metallurgical and industrial calcines
Saves Power, Water, Dust and Headroom

Recent orders received:
The Norton Company (repeat) | Empire Zinc Co. (repeat)
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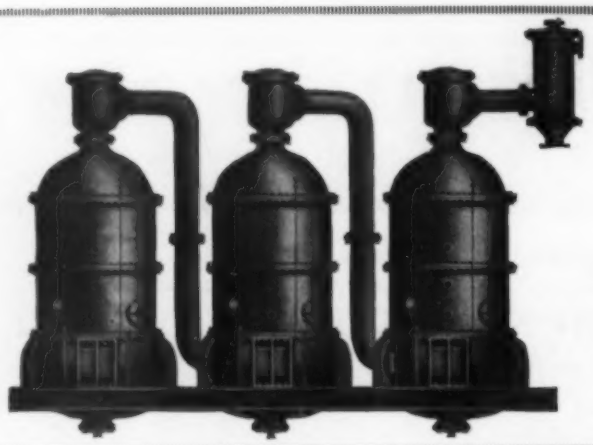
THE STEARNS-ROGER MFG. CO.
Denver, Colo.

Refrigerating Machinery
for the
Chemical and Allied Industries

Water Tube Boilers
Drop Forged Valves and Fittings
"Sectional" Rocking and Dumping Grates
"Sectional" Steel Casings for Boilers

HENRY VOGT MACHINE CO.
LOUISVILLE, KY.



Large Chemical Equipment of Copper

Autoclaves *Extractors*
Evaporators *Stills, Etc.*

GEORGE F. OTT CO.

Coppersmiths, Tankmakers, Machinists

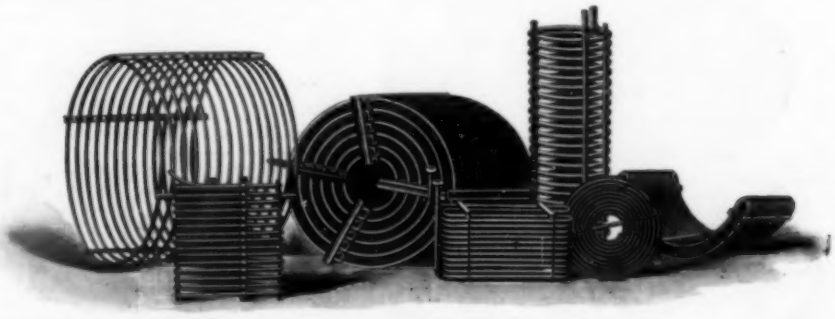
Office: 213 Buttonwood St., Phila., Pa.

Est. 1870 in Phila.

Coils and Bends

—of all kinds are our specialty.

Made of copper, brass, iron or steel pipe or tubing.
For heating, cooling, refrigerating or any other purpose.
We carry a large stock of copper tubing of various sizes and gauges and extra heavy wrought iron and steel coiling pipe, so that we can make prompt shipment.
Estimates furnished promptly. Let us figure on your requirements



THE WHITLOCK COIL PIPE CO., Hartford, Conn.

149 Broadway, N. Y. 10 S. Dearborn St., Chicago 1009 Commercial Trust Bldg., Philadelphia 1042 Granite Bldg., Rochester

Aluminum Company of America

PITTSBURGH, PA.

***Manufacturers of* ALUMINUM**

Ingots, Sheets, Tubing, Wire, Rod, Rivets, Moulding Extruded Shapes, Electrical Conductors

General Sales Office, 2490 Oliver Building, Pittsburgh, Pa.

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CANADA
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Send inquiries regarding aluminum in any form to nearest Branch Office, or to General Sales Office.

We Specialize in

Pure Silver Pipe

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Also many specialties for the chemical and allied industries. Your inquiries are solicited.

A. T. Wall Co.

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"ACIMET" Acid-Proof VALVES

(Trade Mark Registered) (Patented)

mean 100% efficiency in controlling sulphuric acid and other corrosive liquors. Heavy, reinforced construction; will not corrode; are permanent. Wear-reducing disc and seat. Get free trial proposition.

The Cleveland Brass Mfg. Co., Sole Manufacturers
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Model A
Write for Catalog

WONDER PIPE BENDERS
5 MODELS

BEND all sizes of standard or double thick steel, wrought iron, brass and copper pipe from ⅛ in. to 6 in. Used by United States, French and British Governments.

American Pipe Bending Machine Co.
Manufacturers
75 Pearl Street, BOSTON, MASS., U. S. A.

Wash Filter Cloths, Waste and Wiping Cloths with the

Clenzall Washer

Nothing too dirty or greasy

The modern, efficient, economical way. Filter cloths last longer on presses and waste is made better than ever. No "roping" or twisting. Dries by direct squeeze only. Cleans without rubbing the life out of fabrics.

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Hamburg Riveted Steel Tanks

For Air, Oil, Storage and Pressure
3-16 in. to ½ in. metal

Hamburg Boiler Works
Hamburg, Berks Co., Pa.

We have made LEAD LINED IRON PIPE over Twenty Years

Be sure that you use "Amalgamated" Lead Lined Iron Pipe—We are the only makers of that pipe in the United States.

Also Lead Lined Iron **Valves**
Lead Lined Iron **Stop Cocks**
AND
Tin Lined Iron Pipe

Lead Lined **Iron Valve**

MANUFACTURED BY

LEAD LINED IRON PIPE CO. Wakefield, Mass.

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Filter Presses—Tanks

Riveted and Welded Plate Work

Iron Castings—Special Machinery

Sales Offices:
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LEAD CASTINGS

FOR CHEMICAL APPARATUS

WE CAN FURNISH HARD LEAD CASTINGS UP TO 10 TONS EACH IN THE ROUGH, OR MACHINE FINISHED TO SPECIFICATIONS

CRAIG FOUNDRY CO. 42-46 SANFORD STREET BROOKLYN, N.Y.

Let Your Plant Parallel Your "Lab."—

Glass apparatus in your Experimental Laboratory and

PFAUDLER

GLASS ENAMELED STEEL TANKS and APPARATUS

in your Plant. Thus, when you transfer from test-tube lots to ton lots, your laboratory conditions of resistivity and non-contamination will be retained.

Pfaudler Glass Enameled Apparatus will often save a valuable process from the discard through the elimination of corrosion.

Pfaudler Enamels have unusual resistivity, density and tenacity. They are fused into substantial, welded steel shells and are exceptionally durable.

May we discuss your problems with you?

THE PFAUDLER CO.
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Sales Offices: Suite 222, Cutler Bldg.

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A large line

Stuart & Peterson Chemical Apparatus

Standard in the Chemical and Allied Industries because continuously made and sold by us for over 75 years.

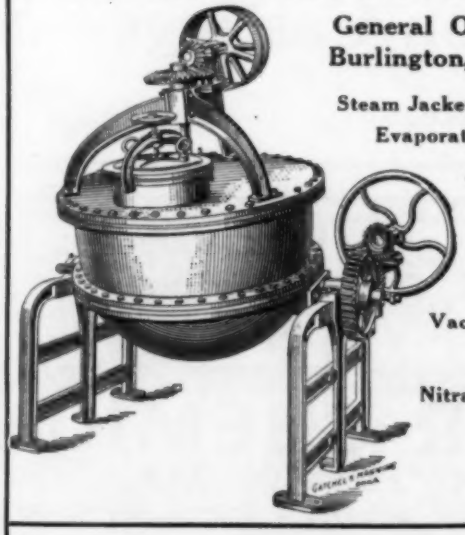
The list of stock apparatus we have designed and made in that time is enormous, embracing practically every device, plain or porcelain lined, that has been found practical for the rapid and profitable manufacture of an endless line of products.

A complete line

Thousands of users of S & P Chemical Apparatus the world over have profited by its superiority and low cost.

Our large complete catalog very convenient for all who cook, boil, evaporate, distill, store, etc.

The Stuart & Peterson Co.



General Offices: Burlington, N. J.

Steam Jacketed Kettles
Evaporating Dishes
Autoclaves
Storage Cans
Sterilizers
Vacuum Stills
Tanks
Nitrating Stills
Annular Kettles

A varied line

Chemical Apparatus Designed and Constructed

CHARGING MACHINE

Stevens - Aylsworth Machinery and Apparatus does the work for which it was intended.

Special Machinery

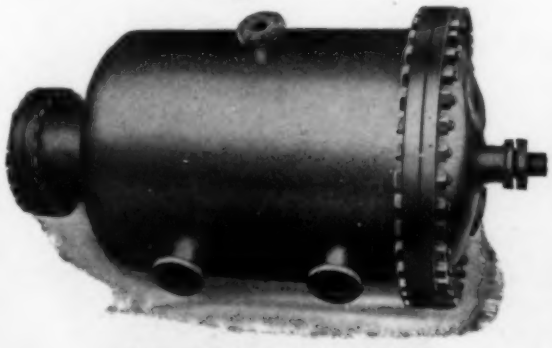
Our varied experience in chemical and industrial engineering is your assurance that an order for a standard or special design will result in something more than just "a machine."

Let us aid you in your preliminary plans. We will design it entirely, if you wish.

Stevens-Aylsworth Co.
253 Broadway
New York City, N. Y.

Kellogg

Forge and Hammer Welded Autoclaves—Stills—Digestors



Forge and Hammer Welded Still

For leakless service and long life.
Also Cyanide Pots, Annealing Kettles and high-pressure tanks of all descriptions, fully guaranteed.
Piping Systems for all purposes.

The M. W. Kellogg Co.
140 Cedar Street, New York

Chemical Castings

Auto Claves Especially

Warren Foundry & Machine Co.
Phillipsburg, N. J.
Sales Offices—11 Broadway, N. Y.
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ELYRIA
-GLASS- ENAMELED
EQUIPMENT

In Cast Iron

The newest Elyria product, designed for service under the most severe and exacting chemical processes.

This cast iron equipment is enameled with our special process enamels which have all the chemical resisting qualities of Chemical Glass and are mechanically tougher, stronger and more elastic. They are positively acid-resistant without metallic oxides, therefore non-poisonous, and are actually fused at about 2000° Fahr. into the metal itself, eliminating danger from cracking, scaling or crazing from contraction or expansion.

In Steel

Bodies are of seamless one-piece welded steel, non-leakable because there are no joints or gaskets.

Lining is the same as is used in the Cast Iron Apparatus.

Made in a large variety of sizes and shapes.

In Steel, Not Enameled

We build our special welded seamless steel apparatus unlined, if desired. All the virtues attributed to our regular apparatus are present, with the exception of the lining.

The Elyria Enameled Products Co.
Elyria, Ohio

NEW YORK 50 Church St. | PITTSBURGH 1237 Oliver Bldg. | CHICAGO 2515 Park Ave.
SAN FRANCISCO 16 California St. | LOS ANGELES 1110 Baker Detwiler Bldg.

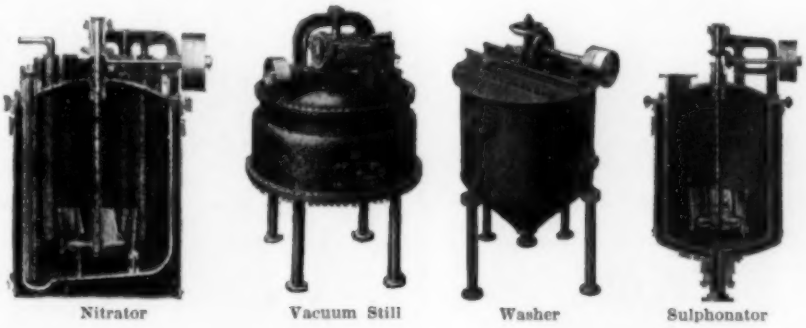
Copper Apparatus

Made by specialists of almost half a century of experience

Material and workmanship first class in every respect.

We make Steam Jacketed Kettles, Varnish Kettles, Vacuum Pans, Stills, Condensers, Seamless Coils, Percolators, Coating Pans, Japanning Ovens, and other sheet metal apparatus. Estimate submitted on receipt of your specifications. Send for our catalog.

Detroit Heating & Lighting Co.
(Established 1868)
Detroit, Mich.



Nitrator Vacuum Still Washer Sulphonator

After so many years of designing and building high-grade, "honest-all-through" Chemical Equipment, is it any wonder that we are never at a loss to make the quality of our finished product synchronize with our printed promises of service and satisfaction?

We undertake many special and difficult problems, and guarantee all of our work.

Stevens Brothers

Engineers—Contractors

Builders of Special or Standard Chemical Equipment

149 Broadway, New York

STYLE B AGITATOR
20-100 Gallon Capacity
Bridge Type, 100-800

STYLE AD AGITATOR
100-800 Gallon Capacity

6 REASONS

why you should

ADOPT THE DOPP

Seamless Kettles—Mixers —Vacuum Pans

The summing up of the six Dopp reasons contained in our advertising of the past few months is as follows:

1—**Cast in one piece.** Kettle, jacket, staybolt (and outlet when desired) are all in one piece; not put together, but cast complete, all at one time, from one ladle of iron.

2—**No joints, therefore seamless and leakless.**

3—**Inner surfaces cast smooth.** No machining. The skin surface, which contributes so much to strength and toughness, is left on.

4—**Heat quicker on account of thin walls.** Means a saving of fuel and time.

5—**Long lasting.** No bolts or rivets to work loose. Dopp apparatus is known to be 40 years in service.

6—**Guaranteed for life.** All-around high quality enables us to safely do this.

Send for Catalog V, Section 1.

Sowers Manufacturing Co.

1302 Niagara St., Buffalo, N. Y.
39 Cortlandt St., New York City

STYLE I AGITATOR
100-800 Gallon Capacity

STYLE D AGITATOR
Bracket Type
20-100 Gallon Capacity
Bridge Type 100-800

Plain or lead lined

WHICH DO YOU CONSIDER FIRST

SERVICE or COST?

HAUSER-STANDER TANKS ARE BUILT FOR SERVICE

WOODEN TANKS FOR EVERY PURPOSE
ANY SHAPE ANY SIZE

The Hauser-Stander Tank Co.
Cincinnati, Ohio

WE WIN WITH QUALITY

TANKS
***of* CYPRESS**
REDWOOD — FIR

Try Redwood for Acid and Alkaline Solutions

Prompt deliveries of any size or shape.
Send us your Specifications.

ACME TANK COMPANY
41 Cortlandt St., New York City

Here's *Your* Copy!

A Mining Catalog Is Ready for You!

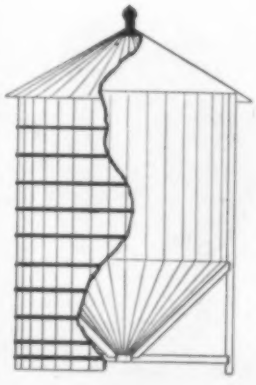
All we need is your name on our mailing-list to send you a copy.

The many uses, forms and construction of Woodstave Tanks are fully described. Besides this, other Cyanide Plant equipment used in late processes of high-grade metal extraction is fully covered.

Such technical data and information are given that the complete catalog makes the most valuable book you have ever seen.

Send for your free copy today

PACIFIC TANK & PIPE CO
THE STANDARD SINCE '66
334 Market St., San Francisco, Cal.



Tanks, Towers and Water Supply Systems for Every Purpose

If you need tanks of wood or metal, any size or shape, towers or a water supply system, regardless of conditions or the purposes for which they are intended, we can satisfy you.

We have filled over 17,000 such orders and our engineering department will be glad to help you solve your problems.

Write us telling your needs and ask for our special circular No. 57.

The Baltimore Company, Baltimore, Md.

WOOD TANKS of every kind—Fir, Cypress, Redwood

Send us your specifications

U.S. WIND ENGINE & PUMP Co.
BATAVIA ILLINOIS
15 WATER STREET

Kalamazoo Tank and Silo Co.
Kalamazoo, Mich.

Wood Tanks—Any Size or Shape

We carry at all times a large supply of tank stock enabling us to make
Prompt Shipment
Send us your Specifications

Corcoran Tanks

Stay Watertight Indefinitely

The Engineering, Designing, Manufacturing and Erection of CORCORAN Tanks is so carefully done that troubles and worries are practically eliminated. If you want a Satisfactory TANK, you may obtain desired information from

A. J. CORCORAN, Inc.
(For 50 Years)
755 Jersey Avenue, Jersey City, N. J.

Stoneware of any description for all purposes

Chas. Graham Chemical Pottery Works
986 Metropolitan Ave. Brooklyn, N. Y.

Wood Tanks

All sizes
All shapes

Plain or
Lead
Lined

Chemical
Metallurgical

Made of Cypress, Yellow Pine, Cedar or Oak. Wood Agitator Tanks and other "Specials" promptly delivered. Our stock of lumber is large, and we can quickly make up what you need.

J. Schwarzwalder & Sons, Inc.

Established 1853

15th and Jefferson Streets, Hoboken, N. J.

Eagle Tanks

WE Build everything needed by the chemical industries in the line of

Wood Tanks, Vats, Sulphur Towers, etc.

and our prices are interesting. Be sure and get our estimates before placing your order.

Eagle Tank Co.
2442 W. Crawford Ave.,
Chicago, Ill.

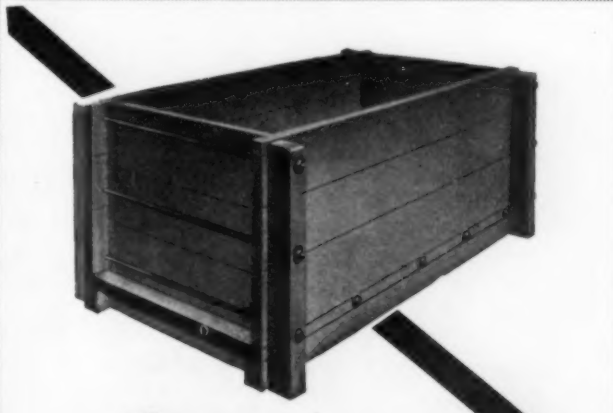
WOOD TANKS

For 25 years we have been building quality wood tanks.

ALL SIZES AND ALL PURPOSES

JOHNSON & CARLSON

848 to 864 Eastman St. CHICAGO



NATIONAL QUALITY

Tanks

For Chemical Works and Industrial Plants

We make anything and everything in this line, from the smallest storage tank to the highest tower tanks of 100,000 gallons capacity—or larger.

Tanks for mining or cyanide plants, chemical works, storage, plating, tanning, etc. A large line carried in stock, Estimates submitted upon receipt of specifications.

National Tank & Pipe Co.

275-T Oak Street, Portland, Ore.

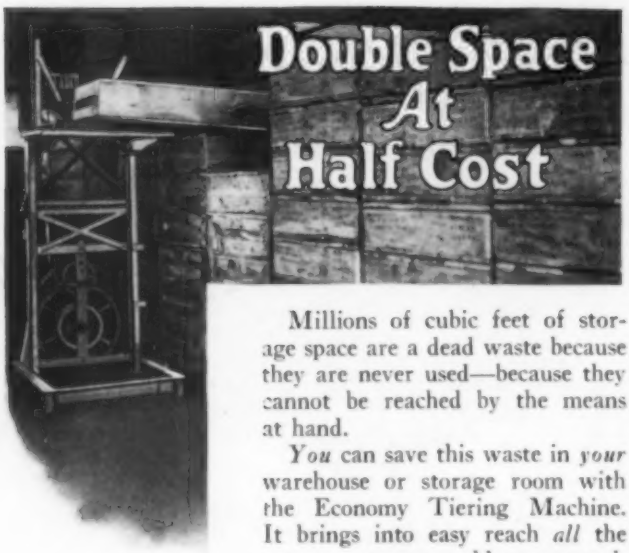
Eastern Representative—Dewar Manufacturing Company, Bush Terminal, Brooklyn, N. Y.

WENDNAGEL TANKS

Many years of experience, modern factory, central location for materials, and our determination that the best tanks procurable are **truest economy** and therefore the best business builders,—are your assurances of long and satisfactory service of WENDNAGEL TANKS. GET OUR PRICES.

Round, Rectangular and Oval Tanks

WENDNAGEL CO.
CHICAGO, ILL.



Millions of cubic feet of storage space are a dead waste because they are never used—because they cannot be reached by the means at hand.

You can save this waste in *your* warehouse or storage room with the Economy Tiering Machine. It brings into easy reach *all* the space your men could never reach before. The

ECONOMY Tiering Machine

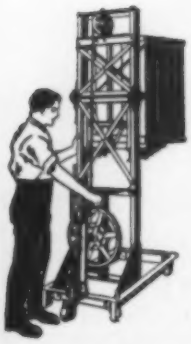
enables you to use every inch of space as high as the fire restrictions will permit. The Economy brings down the cost of your space per package according to the amount of space it brings into use.

Whether you have boxes, barrels, bales or crates to pile, the Economy is the only *safe* means of doing the work. And it doesn't matter how heavy the packages may be.

Saves Labor Too

The *heavier* the packages the more men you *save* when you use the Economy Tiering Machine—for one man does as much as three to seven. In several cases one man handles crates weighing 1000 pounds—and does it with ease.

Where a number of men get in one another's way, the Economy saves hours of time. And what is still more, it releases labor for more productive work, thus serving a patriotic purpose as well.



Nine Overwhelming Features

There are nine important reasons why you need the Economy Tiering Machine and why you should choose it in preference to other makes. As a safeguard of your own interests you should read our folder describing the nine essential features.

Write Today

It takes but a moment to say on a postcard, "Send me the nine overwhelming features." To put it off till tomorrow is to run the danger of forgetting it entirely. So write now while the idea is fresh.

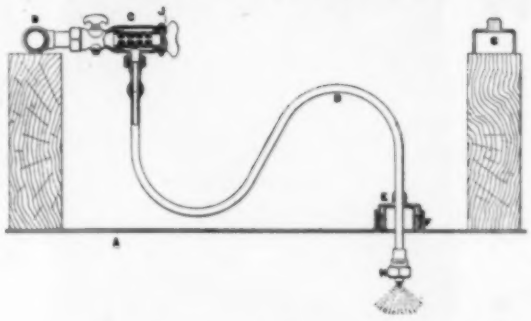
Economy Engineering Co.

Also Manufacturers of Economy Steel Barrel Racks

431 South Washtenaw Ave., Chicago
85 Murray Street, New York

Foreign Agents: Brown Portable Elevator Co., Chicago.

SUMMER WEATHER



Increase Your Production by Using Water Sprays

WITCLAY—Stoneware—Nozzles give highest absorption, greatest resistance to erosion, corrosion, and temperature changes. Made in accordance with our famous standard.

SPRAY EQUIPMENT—ALL PURPOSES—ALL MATERIALS.

Acid Handling—Automatic Blow Case—Air Jet Lifts—Steam Syphons—Centrifugal Pumps.

All the foregoing made by

Schutte & Koerting Company

Thompson and 12th Sts. Philadelphia, Pa.

New York, 50 Church St.; Boston, 10 High St.; Kansas City, Burton Machy. Co.; Denver, 1st Nat. Bank Bldg.; Chicago, Security Bldg.; Pittsburgh, Oliver Bldg.; Cleveland, Union Bldg.

MONARCH

Stone Sprays

Cut shows one of our Standard Sulphuric Acid Chamber Sprays, which **can be cleaned while in operation.** The entire nozzle is made of stone, socket of lead, but

FOR NITRIC ACID

we make nozzles entirely of stone. The nozzles give perfect atomization.

We make sprays for every purpose, any capacity and of any material. State requirements.

Monarch Manufacturing Works, Inc.
3127 Emery Street, Philadelphia, Pa.

HOW TO PILE BARRELS

One or two men with a Revolvator will do the work of several men in piling barrels, bales, cases, etc. With a Revolvator you can pile the heaviest load clear to the ceiling thereby utilizing all the storage space.

Write for Bulletin No. EL 42.

REVOLVATOR CO.

379 Garfield Avenue Jersey City, N. J.

Sales Agents: N.Y.Revolving Portable Elevator Co.

E. H. SARGENT & CO.

Importers, makers, dealers in Chemicals and Chemical Apparatus of High Grade only

125-127 W. Lake St. CHICAGO, ILL.

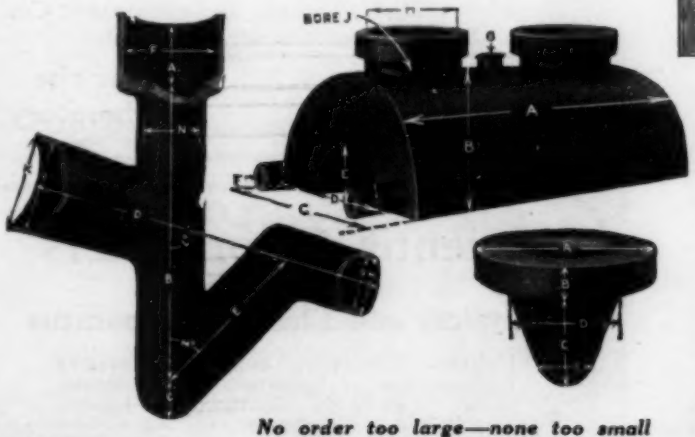
GROWTH

As with the Oak, so with great manufacturing plants—from small beginnings to overshadowing supremacy. The growth of what is now the great General Ceramics Company has been steady and sure, because rooted in QUALITY. Today we can say, in sober fact, that we are the largest single Company in this country producing EVERYTHING in Chemical Stoneware. Incidentally, we carry on hand pots and tanks up to 1000 gals. capacity; and other equipment. May we serve you?

General Ceramics Company
50 Church Street, New York
Chicago Office: 112 West Adams Street

Acid-proof Stoneware for Chemical Purposes

This healthy (twins) plant is growing so rapidly that this picture fails to do it justice. Largest of its kind in the United States



No order too large—none too small to get our best attention.

Don't become confused and associate the chemical stoneware manufactured by the U. S. Stoneware Co., with that which is made from mixtures of transient clays, because stoneware thus made is unreliable, never giving best results and never twice alike.

We command from our own mines clay and coal which has largely formed the basis of our great success. Specially prepared for each distinct purpose, our clay *never fails.* When fired to a heat of 2800° F. or more it still has *life* to expand or contract under the most trying changes of temperature.

PLEASE NOTE—If a prospective purchaser, we invite you to come to our plant, ask us for demonstration of the severest character, which we will show you, and thus prove our claim for superiority.

U S STANDARD
THE U.S. STONEWARE CO. AKRON. OHIO.

THE U. S. STONEWARE COMPANY

Our Elaborate Catalogue is awaiting your request.

Established 1865 Akron, Ohio, U. S. A.

Offices and Factory No. 1, 160 to 172 Annadale Ave.; Factory No. 2, 221 to 273 Fountain St.

Weston Electrical Indicating Instruments

are unqualifiedly superior to any other instruments designed for the same service.

A.C. or D.C. Switchboard or Portable Instruments for every field of Indicating Electrical Measurement. In writing for catalogs and bulletins, please specify the field that interests you.

WESTON ELECTRICAL INSTRUMENT CO.
77 Weston Ave., Newark, N. J.
23 Branch Offices in the Larger Cities

GAS For Laboratory and Industrial Uses

(Made from Gasoline)

The "DETROIT" Combination Gas Machine

Automatically makes the best and cheapest gas for—

Laboratory Uses of Every Character
Also Heating, Cooking, Lighting
(Over 30,000 in daily use)

Descriptive catalog and names of users in your locality sent on request.

"DETROIT"
Laboratory Bunsen Burner

When in need of Laboratory Burners think of the

"DETROIT"

The style and design speaks for itself. Separate control of both Air and Gas. Tripod Base that will always set level. Guaranteed to work on City, Natural or Gasoline-gas. In your next order specify "Detroit" and get the best.

Detroit Heating and Lighting Co.
(Established 1868)
605 Wight St., Detroit, Mich.

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Recording Instruments

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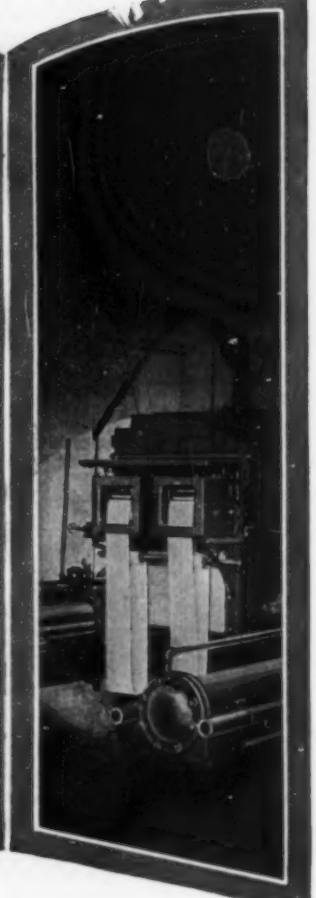

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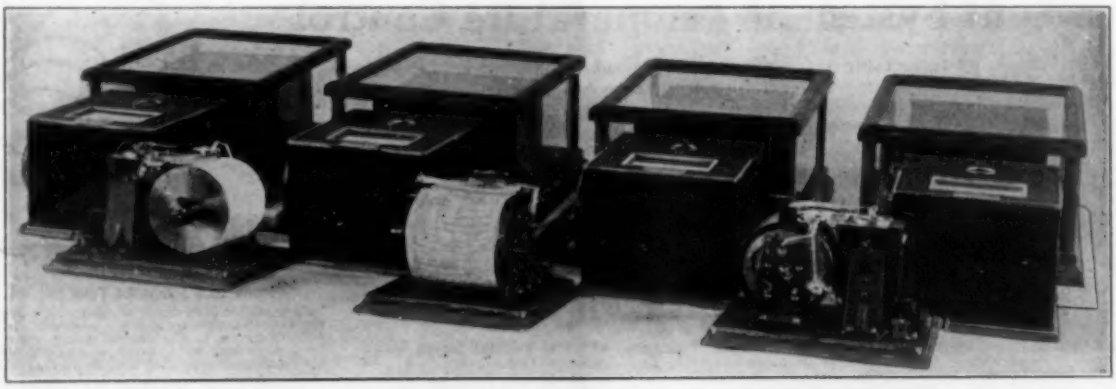

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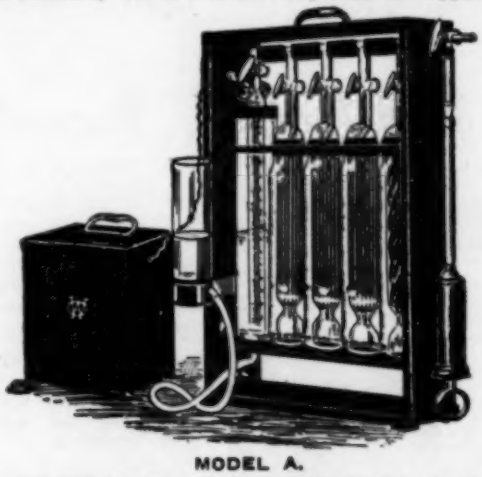

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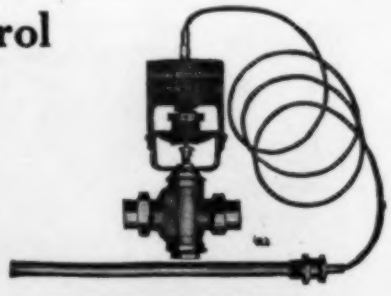

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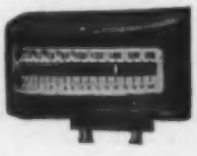

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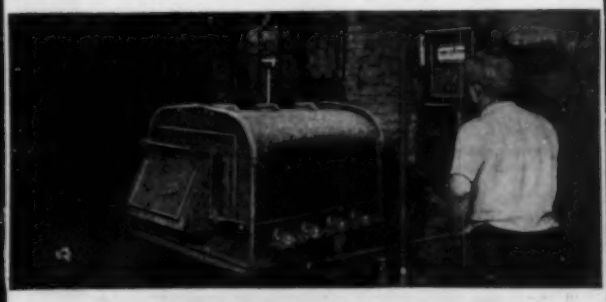
Brown Pyrometers



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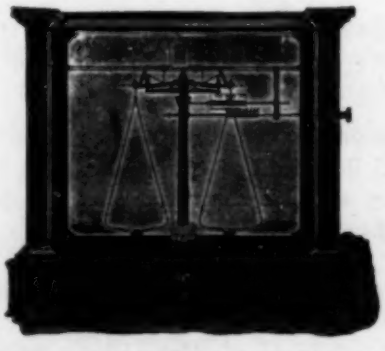

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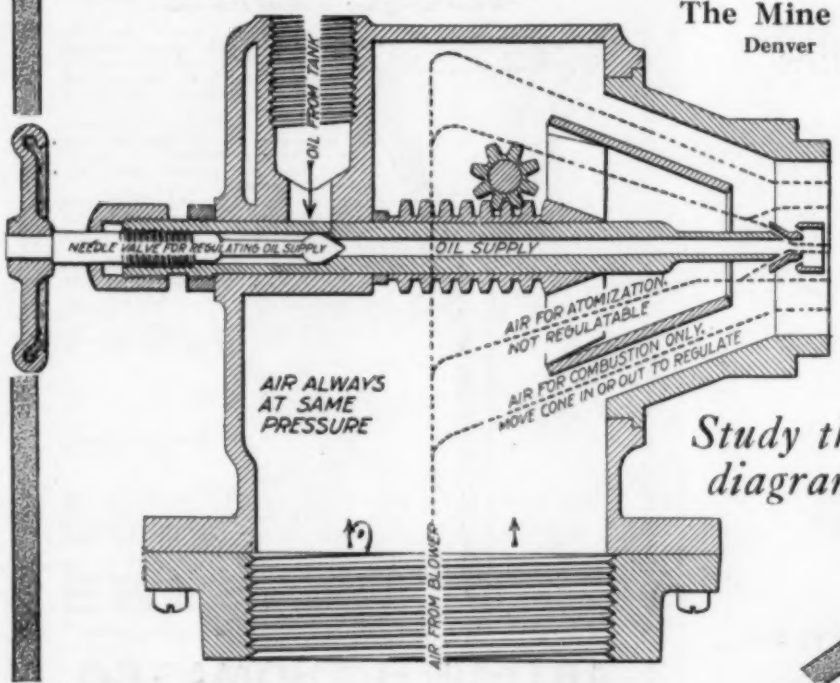
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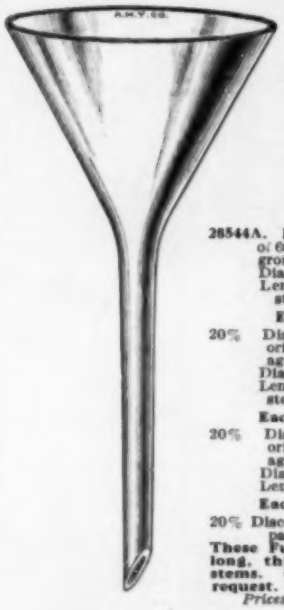

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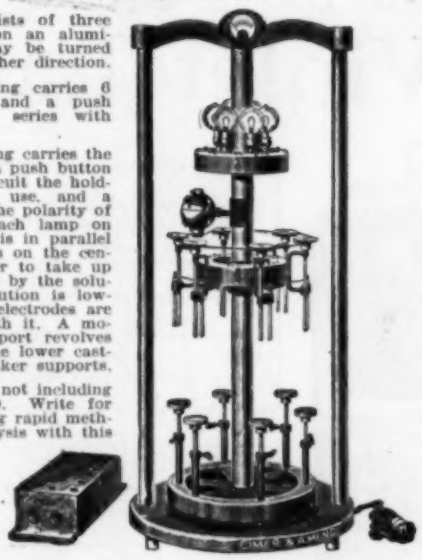

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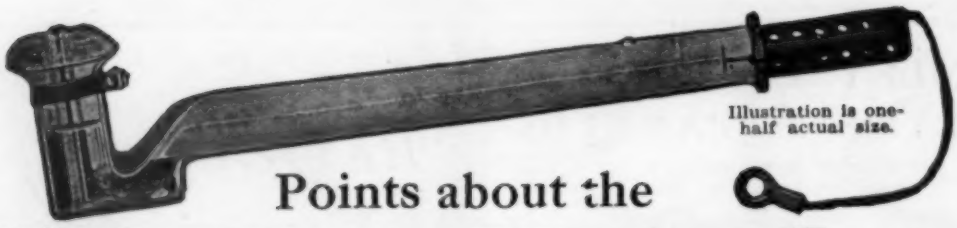

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Solves many vexing problems in the laboratory.

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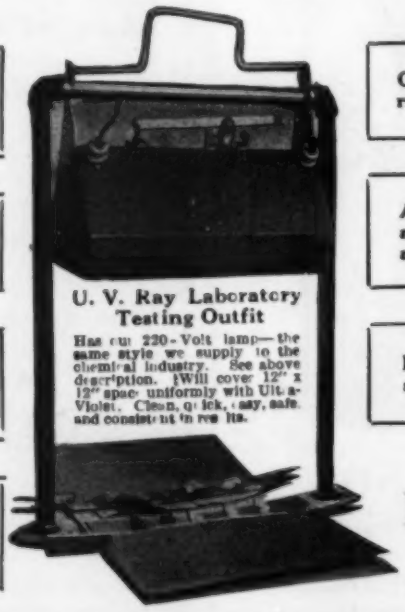

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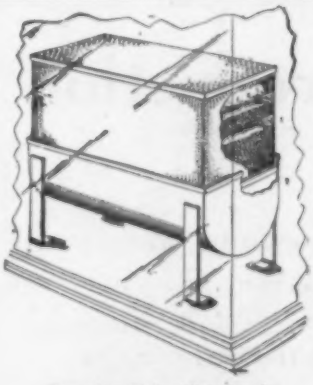

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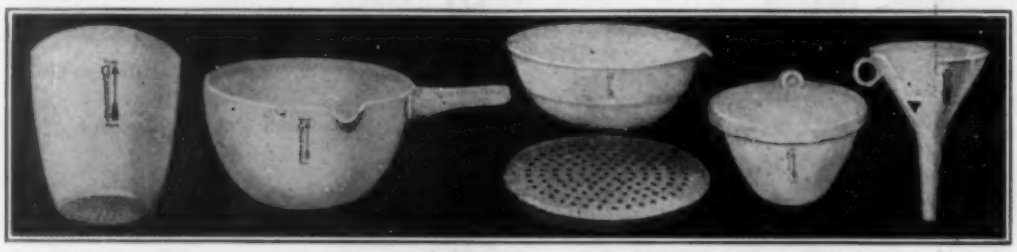

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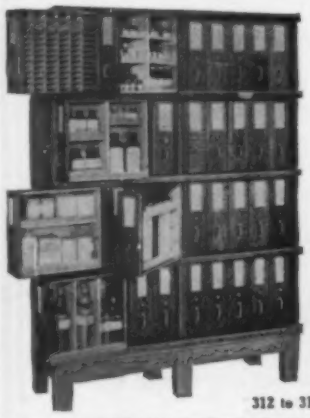

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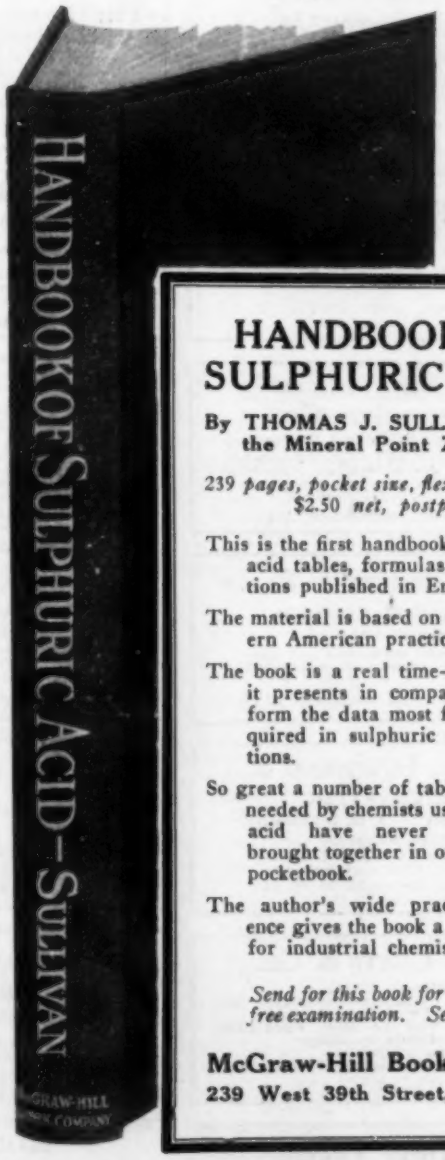

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for immediate delivery, with full set of special brick and shapes and steel jacket for setting, also 4-ft. by 60-ft. steel stack. This boiler, designed for 200 lb. working pressure, was used only two months in experimental plant and is fully equal to new. Address

PHOENIX REFINING CO.
Tulsa, Oklahoma

STOKERS

5000-H.P. Approx. Jones Patented Under Feed Stokers. A-1 physical and mechanical condition. Discontinued from service only on account of increased Stoker capacity per Boiler required.

PAUL STEWART & CO.
Electrical and Steam Machinery
First National Bank Bldg., Cincinnati, O.

SEARCHLIGHT SECTION

Just One Slip

of a bottle of chloro-platinic acid may cost you more than a year's supply of

Perchloric Acid, C. P.

3 cents' worth of which replaces $8.00 worth of platinic chloride

For Potash Determinations

GENESEE CHEMICAL COMPANY
Dept. E, **Batavia, New York**

Analytical method furnished upon request.

Frequency Changer

Immediate Shipment

1000-Kw. Westinghouse Frequency Changer Set, 60-Cycle, 3-Phase, 2300 Volts: to 25-Cycle, 3-Phase 6600 Volts. All on sub-base, complete with Starting Motor and all usual accessories.

PAUL STEWART & COMPANY
Large Electrical and Steam Power Apparatus
First National Bank Building, Cincinnati, Ohio

Plain and Steam Jacketed Kettles, Autoclaves, Retorts and Other Chemical Apparatus

of 1/8- to 5/8-inch material, lined with tin, lead and copper; corrugated transformer tanks and various pressed steel articles.

BUILT on CONTRACT

We have a large shop, employ ten welders and other skilled labor, have been in business six years and can guarantee prompt and satisfactory service. Let us know your requirements.

YOUNGSTOWN WELDING CO.
536 W. Rayen Ave., Youngstown, Ohio

RUSH! We can rush the following and many other items to your plant.

2—30-in. Shriver Wooden Filter Presses.
4—24 in. Shriver C. I. Filter Presses.
1—No. 9 Sweetland Filter Press.
1—No. 6 Sweetland Filter Press.
1—26 in. Tolhurst Centrifugal.
8—30 in. American Centrifugals.
1—Proctor Dryer 22 ft. x 13 ft. x 7 ft.
2—Atmospheric Drum Dryers, 4 ft. x 8 ft.
2—Atmospheric Double Drum Dryers, 4 ft. x 9 ft.
1—11 Shelf Buffalo Vac. Dryer.
1—17 Shelf Devine Vac. Dryer.
1—5 ft. x 25 ft. Devine Rotary Vac. Dryer.
2—30 in. x 16 in. Ball Mills.
2—30 in. x 30 in. Ball Mills.
4—6 ft. x 11 in. Steel Stills.
1—10 ft. 8 in. x 12 ft. 9 in. Steel Still.
4—No. 1 Anderson Expellers.
2—2000 gal. Enameled Tanks.
1—9000 gal. Closed Tank.
2—1000 gal. Open Tank.

Let us have your inquiries.

CONSOLIDATED PRODUCTS COMPANY
15 Park Row, New York Barclay 8180.

$40,000,000 Potash Tailings

We own approximately 8,000,000 tons of Tailings that will average 10% K_2O. They are crushed to minus 100, are located at Colorado Springs, Colo. Lime beds on the property. These tailings are from Cripple Creek ore. A rare opportunity for anyone having a process for obtaining the Potash from Silicates. Will sell outright or lease to responsible parties.

The Morse Bros. Machinery & Supply Co.
Denver, Colo.

WE BUY SCRAP PLATINUM or any material containing Gold, Platinum or Iridium
WE PAY MARKET PRICES

Consignments held subject to your acceptance of our offer.

GOLDSMITH BROS. SMELTING & REFINING COMPANY
Chicago, Heyworth Bldg., New York, 20 John St., Seattle, Green Bldg., Toronto, 24 Adelaide St., W.

ROTARY VACUUM DRYER

WANTED

complete with pump and condenser; 3 ft. in diameter and 10 to 15 ft. long. Approximate capacity per charge, 2000 to 4000 lb. State price, make, delivery and length of service of dryer offered.

W-305, Met. & Chem. Engineering
Real Estate Trust Bldg., Philadelphia

Little "WANT" cards bring big results in Metallurgical and Chemical Engineering

Keep your eye on the Searchlight and your advertisements in it.

SEARCHLIGHT SECTION

FOR IMMEDIATE SHIPMENT

2—30,000 gallon, triple effect

Evaporators

Practically new, complete with all accessories, made in U. S. A., and will return duty free.

CHEAP FOR QUICK SALE

BURNS & ROBERTS

Bank of Hamilton Bldg.,
Toronto, Ont., Canada

POSITION VACANT

WOOD DISTILLATION

Large manufacturing concern is contemplating building a plant for hardwood distillation, and will require for this purpose a

CHEMICAL ENGINEER

with good theoretical education and long experience, who could at first act in consulting capacity and later on take charge of the manufacturing end. Must be able to carry out research on byproduct improvements.

Forward application to this Journal, marked *Wood Distillation*. State education, nationality and salary wanted.

P-303, Metallurgical and Chemical Engineering
10th Avenue at 36th St., New York

Advertisements in the Searchlight Section of *Metallurgical and Chemical Engineering* bring results.

PAUL STEWART AND COMPANY

FIRST NATIONAL BANK BLDG. ELECTRIC AND STEAM MACHINERY CINCINNATI, OHIO U.S.A.

A-1 Apparatus: Partial List: Immediate Delivery:

BOILERS

3—500-hp. Edgemoor, 200-lb. working pressure Water Tube Boilers, two years service, without grates with Jones Stokers, no Superheaters. Excellent condition.
1—557-hp. Stirling, 150-lb. hand fired Drums, lap seam Boiler, perfect condition.
2—480-hp. Stirling. Built for 160-lb. pressure. Drums lap seam Hand Fired Fronts, two years' service, as good as new.
2—485-hp. Heine 200-lb. working pressure, hand fired fronts complete. Two years service. Perfect condition.
2—150-hp. vertical Lynne safety water tube boilers complete with hand fired Fronts, 125-lb. allowance. Boilers in good sound condition.
3000-hp. Jones Stoker, suitable for reinstallation with any of the above if required.

OIL OR GAS ENGINES

1—90-hp. Meitz & Weist, complete.
1—50-hp. Meitz & Weist, complete.

A.C. UNITS

2—3000-kw. General Electric, 25-cycle, 3-phase Alternators, direct connected to vertical cross compound Corliss Engines.
1—1500-kw. Westinghouse-Parsons (old rated), actual capacity, 3200-kw., 60-cycle, 2 or 3-phase, 2300-4000-volt. Condensing Turbo Alternator complete.
1—1500-kw. General Electric (old rated), actual capacity 2500-kw., vertical Condensing Turbo Alternator Unit, 60-cycle, 3-phase, 2300-volt. Complete with condensing equipment.
1—1200-kw. Revolving Field, 60-cycle, 2- or 3-phase, 2300-volt alternator, with heavy duty cross compound engine.
1—1000-kw. Westinghouse-Parsons (old rated,) actual capacity 2000-kw., 60-cycle, 3-phase, 2300-4000-volt, turbo alternator complete.
1—800-kw. General Electric revolving field type alternator, 60-cycle, 3-phase, 2300-volt, direct connected to heavy duty cross compound Corliss engine.
1—500-kw. Old Rated (actual capacity 750-kw.), 60-cycle, 3-phase, 2300-volt vertical condensing turbo alternator unit, complete with surface condenser.
1—500-kw., same as above, 440-volt, 3-phase.
2—400-kw. Westinghouse, 25-cycle, 3-phase, 440 volt, direct connected to Cross compound Corliss engines.
1—625-kv.-a. Crocker-Wheeler Engine type Alternator, 60-cycle, 3-phase, 240-volt, for direct connection at 225-r.p.m., without engine.
1—50-kv.-a. Crocker-Wheller Alternator, 60-cycle, 3-phase, 220-volt, 1200-r.p.m.

MOTORS

1—1200-hp., 25-cycle, 3-phase, 2200-volt, 250-rev. Slip Ring Motor, complete.
1—250-hp. Burke, 60-cycle, 2-phase, 2300-volt Synchronous Internal resistance motor, with panel coupled to 24-in. Platt twin rotating pump, twenty million G.P.D., 45-ft. head.

STACKS

1—66-in. x 100-ft. Guyed Stack, First-Class Condition.
2—84-in. x 102-ft. Guyed Stack, First-Class Condition.
1—12-ft. x 133-ft. self-supported Guyed Stack, First-Class Condition.
1—12 x 190, self-supported, practically brand new.

DRYERS

2—6 x ft 20-ft. steam or indirect heat Rotary Dryers.

CRANES

1—20-ton Northern Crane, bridge 32-ft. span.
1—20-ton Hand Operated Crane, 54-ft. span.
1—5-ton Yale & Towne K.Y., 26-ft. span, 60-cycle, 3-phase, 220-volt.

ENGINES

1—18 x 36 Allis-Corliss.
1—18 x 42 Lane & Bodley.
1—20 x 42 St. Louis Corliss.
1—22 x 48 Harris-Corliss.
1—22 x 40 Nordberg Corliss.
1—24 x 48 Hamilton, heavy duty.
1—30 x 48 Bates Corliss.

CONDENSER

1—850-sq.ft. Surface Condenser.

HEATERS

1—900-hp. Cochran Heater.
1—6000-hp. Cochran Heater.

DIRECT-CONNECTED UNITS

2—1600-kw. General Electric, 500-volt, direct current Generators, with Cross compound, heavy duty Corliss engines.
2—500-kw., 250-volt, direct current Engine Type Generators, with heavy duty Corliss engines.

Advise Your Requirements—We Can Assist

SEARCHLIGHT SECTION

AUCTION SALE
of valuable Graphite Property
Near Buckingham
Province of Quebec, Canada

The undersigned will offer for sale by public auction at W. A. Cole's Auction Rooms, No. 63 Sparks Street, in the City of Ottawa, Canada, at 2:30 o'clock in the afternoon, of the

Tenth day of September, 1918

the property known as the "Walker Graphite Mine" in the Township of Buckingham, comprising about 1250 acres of land, held in fee simple. The property is situated about six miles from the Town of Buckingham, on the Canadian Pacific Railway between Montreal and Ottawa, and less than ten miles from the landing on the Ottawa River. The quantity of ore is practically inexhaustible and the mining facilities are exceptional.

The buildings consist of refinery, engine and boiler house, manager's dwelling, foreman's dwelling, and other buildings. The lands are well timbered and contain ample supplies for mine purposes and fuel. The right to cut basswood until the 1st day of March, 1919, has been sold.

A large quantity of machinery, plant and tools on the property will also be sold as a separate lot. Both sales will be subject to reserved bids.

Applications to inspect the property may be made to Mr. Sam. Devine, Buckingham, Quebec, Canada, and further particulars may be obtained from

M. J. GORMAN, Vendor's Solicitor,
Union Bank Building, Ottawa, Canada.
W. A. COLE, Auctioneer.

Chemical Laboratory
FOR SALE

We are offering for sale the Chemical Laboratory of the late Frank P. Drane, of the city of Charlotte, North Carolina. This Laboratory is well equipped for assaying and for testing of cements and asphalts as well as for general chemical research. A complete list of the inventory will be mailed to interested parties.

AMERICAN TRUST COMPANY
Administrator of Frank P. Drane, deceased
Charlotte, N. C.

BUSINESS WANTED

Chemical Engineer wishes to buy an interest in a good permanent business where his experience would be of value.
Has successful record as executive in a large plant manufacturing heavy chemicals and organic compounds. Would join reliable organization on war contracts.

BO 331—Met. & Chem. Eng.,
1570 Old Colony Bldg., Chicago

BUSINESS OPPORTUNITIES

Synthetic Gutta-Percha

Inventor of Synthetic Gutta-Percha is ready to issue license for its manufacture and application. Would like to communicate with responsible party. BO-310, Met. & Chem. Engrg.

NEW MOTOR GENERATOR SETS

GENERATORS 250-275 VOLT, MOTORS 2300 VOLT, 3 PHASE, 60 CYCLE
1—100 KW., DELIVERY JUNE 5TH.
1—150 KW., DELIVERY MAY 20TH
1—200 KW., DELIVERY MAY 20TH.

NEW MOTORS FROM STOCK

Three-Phase, 60-Cycle

Qu.	H.P.	Make	Volts	Type	Speed
2	5	G. E., New	220/440	Sq. Cage	1200
1	7½	Watson	220/440	Sq. Cage	1130
1	7½	G. E.	220/440	Sq. Cage	900
1	7½	G. E.	220/440	Sq. Cage	1200
5	20	Westghse.	220/440	Sq. Cage	900
1	25	G. E.	440	Sq. Cage	900
1	25	Allis-C.	220/440	Sq. Cage	1160
1	50	Allis-C.	220/440	Sq. Cage	900
1	100	G. E.	220/440	Sq. Cage	720

Two-Phase, 60-Cycle, from Stock

Qu.	H.P.	Make	Volts	Type	Speed
1	40	Westghse.	220/440	Sq. Cage	870
1	50	Westghse.	220/440	Sq. Cage	690
1	35	Wagner	220/440	Sq. Cage	700

Three-Phase, 25-Cycle, from Stock

Qu.	H.P.	Make	Volts	Type	Speed
2	30	A. C., New	220/440	Sq. Cage	720
2	40	A. C., New	220/440	Sq. Cage	720
2	50	A. C., New	220/440	Sq. Cage	720

Direct-Current Motors, from 5 to 30 hp., in Stock. Also Cutler-Hammer Controls for A.C. & D.C. Motors.

IF YOU ARE IN THE MARKET FOR TANKS SEND FOR MY BULLETIN NO. 10-F.

A B C CO. NEW DISC VENTILATING FANS IN STOCK.

TYPE D, BASE OR FLANGE, 18 TO 30 in. DIAMETER. ALSO ONE 42 in., AND 3—54 in.

VENTURA DISC VENTILATING TYPES, SIZES FROM NO. 3 TO NO. 9, BOTH BASE AND WALL TYPES, FROM STOCK.

HOWARD B. PAYNE
Steam-Electric-Mining-Machinery
House Building | PITTSBURGH, PA.

FOR SALE

Filter Press For Sale

One Filter Press. Thirty-six (36") inch square, 44-chamber, center-feed, open delivery washing type; constructed of wood for filtering acid solutions. Used only two weeks; in perfect condition; may be inspected; located in Brooklyn, N. Y. FS-290, Met. & Chem. Engrg.

Magazines Bought and Sold

We buy and sell numbers of "Metallurgical and Chemical Engineering," "Chemical Abstracts" and other technical and industrial journals. The H. W. Wilson Company, 960 University Avenue, New York.

POSITIONS VACANT

ASSISTANT chemist wanted in Commercial assay laboratory in New York City for work on Metals and Alloys. State experience, age and salary desired. Must be draft exempt or deferred classification. P-324, Met. & Chem. Engrg.

CHEMICAL engineer wanted for Pacific Coast plants now in operation. Man of broad experience with executive ability will be given an opportunity to fill important position. Write full particulars, age, experience, salary required. P-308, Met. & Chem. Engrg.

CHEMICAL Engineer Wanted, with 5 or 6 years' experience in plant investigation. Must have thorough chemical training and experience, preferably along the lines of acid and alkali manufacture. P-326 Met. & Chem. Engrg.

OPERATOR wanted for electric melting furnace, who has had experience on non-ferrous metals. State experience and salary expected. P-307, Met. & Chem. Engrg.

POSITIONS VACANT

CHEMICAL engineer with experience in synthetic coal tar byproduct industry wanted. State experience and salary expected. The Barrett Co., Chemical Department, Frankford, Philadelphia.

CHEMICAL engineer with experience in manufacture of acids and alkali wanted. State experience and salary expected. The Barrett Co., Chemical Department, Frankford, Philadelphia.

CHEMIST wanted by chemical manufacturing plant in New Jersey. Prefer young man draft exempt. Research and practical manufacturing experience desirable. Give full details in first letter. P-309, Met. & Chem. Engrg.

CHEMIST wanted to assist in analytical and research work in laboratory of large manufacturing plant near New York. State age, training, experience and salary desired. References required. P-306, Met. & Chem. Engrg.

FIRST-CLASS superintendent wanted to take charge of a 200-ton chamber sulphuric acid plant in the East. Applicants must have had sufficient experience to operate a plant of this size successfully and economically on either sulphur or fines pyrites. Liberal salary and good opportunity to right man. Applications kept confidential. P-218, Met. & Chem. Engrg., Phidadelphia.

METALLOGRAPHIST. Technical graduate wanted for work in experimental laboratory of large New England manufacturing concern. Knowledge of metallography of steel essential. Practical experience desirable, but not required. P-139, Met. & Chem. Engrg.

EXPERIENCED mechanical engineer; preferably one having experience in chemical plant. P-29, Met. & Chem. Engrg.

SAMPLER wanted about July 1st. Man to take charge of sampling in large industrial plant for Chemical Department. Must have experience in sampling along metallurgical lines and be able to handle men. Should be thoroughly acquainted with crushing machinery. P-327, Met. & Chem. Engrg.

YOUNG man wanted by manufacturing plant in Hoboken, who is capable of making analysis of steels and metals. P. O. Box 55. Hoboken, New Jersey.

POSITIONS WANTED

ASSISTANT chemist, twenty, executive experience, three years technical training, two years' analytical and manufacturing experience in the organic and inorganic field. Prefer a position with a manufacturing concern. PW-330, Met. & Chem. Engrg.

CHEMIST, graduate, 3 years' factory experience in glycerine, fats, oils, soap, sulphonated oils, well acquainted with vacuum evaporators, filter presses, drying machinery and technical research, Class 1, limited service, desires position in chemical works. PW-329, Met. & Chem. Engrg.

CEMENT inspector wants position; has own laboratory. PW-212, Met. & Chem. Engrg.

CHEMIST
WANTED

Not liable to draft, for research and experimental laboratory in big mineral oil refinery in Texas. State training, experience, and salary expected to start.

P-321—Metallurgical & Chemical Engrg.
1570 Old Colony Bldg., Chicago

SEARCHLIGHT SECTION

ENGINEERS
—MECHANICAL
—ELECTRICAL
—CHEMICAL

WANTED

by large Electro-chemical Company in New York State for apprenticeship course leading to operating or research positions. This work offers a variety of experience and opportunity. Send for application blank.

P-289, Met. & Chem. Engrg.
10th Ave. at 36th St., New York

A large manufacturing concern in the middle west is increasing its Research Laboratories, and has a number of

POSITIONS OPEN
for
ANALYSTS and CHEMICAL ENGINEERS
and
EXPERIENCED RESEARCH WORKERS

Splendid opportunity for advancement and interesting work of diversified nature, and permanent employment.

In making application give all particulars in regard to experience and education, liability to military service, and salary expected to start.

P-295, Metallurgical & Chemical Engineering
1570 Old Colony Bldg., Chicago

WANTED

Mechanical and Chemical
ENGINEERS
and
DRAFTSMEN

If you are not employed on important Government work, please apply to

CHEMICAL CONSTRUCTION CO.
Charlotte, North Carolina

POSITIONS WANTED

ASSISTANT superintendency or works managership desired by graduate electrochemist, age 25, deferred draft classification, now employed in supervisory capacity on drawn metal work. Two years responsible experience in copper and lead smelter. Excellent record throughout. Will consider $1800 with right concern. PW-274, Met. & Chem. Engrg., Chicago.

CHEMICAL engineer, beyond draft age, desires permanent position; can design, install, operate or manage chemical plant or assist at same; American; practical, with years of factory practice and in executive position; salary moderate if the I can be valuable in any chemical plant, work can be in dyestuffs or intermediates; G. S., 41 North 16th St., East Orange, N. J.

CHEMICAL engineer; now directing manufacturing researches. Draft exempt. Inorganic and metallurgical experience. Capable taking charge small industrial laboratory. Salary $2200. PW-311, Met. & Chem. Engrg.

CHEMICAL engineer, University graduate, thorough theoretical and practical knowledge of chemistry, organic and inorganic, analytical, physical, manufacturing; non-ferrous metallurgy (concentration and smelting), electro-chemistry, etc. Extensive and varied experience in both laboratory and large-scale operations, as executive and in handling men. Only high-grade position considered. PW-255, Met. & Chem. Engrg., Chicago.

CHEMIST with laboratory, can arrange part time elsewhere; analytical experimental, etc.; supervisory or otherwise. PW-299, Met. & Chem. Engrg.

A corporation engaging in the manufacture of heavy chemicals and technical products has several positions open wherein experienced, capable technical men may, upon proving their worth, secure recognition of this in positions of responsibility which carry remuneration in keeping with same:

CHEMICAL PLANT EXECUTIVES
CHEMICAL ENGINEERS
WORKS ENGINEERS
ACID PLANT SUPERINTENDENTS
CHEMISTS

should make applications for interview, outlining fully in this their record, qualifications and references.

Applications of high class men of unquestionable record, stability and competency only will be considered, as this type only is desired. Salary and opportunities offered are in accordance with this.

P-332, Metallurgical & Chemical Engrg.
36th St. at 10th Ave., New York

POSITIONS WANTED

CHEMICAL engineer, university graduate, 28, married, 2 years' experience in physico-chemical research and testing of ferrous and non-ferrous alloys, metallography, pyrometry, and thermal analysis, now employed, wishes position as metallurgist with responsible manufacturing concern. PW-319, Met. & Chem. Engrg., Philadelphia.

CHEMIST with originality, capacity and efficient executive ability and with five years of successful research and manufacturing experience in the electrolytic production of organic and inorganic compounds, also research experience in important analytical control and in electroplating—offers all this to the right party for a reasonable compensation. PW-323, Met. & Chem. Engrg.

CHEMIST—University graduate, M. S. degree, 5 years' actual experience in plant and research desires position involving responsibility and where results count. Lowest salary considered $2400. PW-278, Met. & Chem. Engrg.

CHIEF chemist, now employed, with fine plant and laboratory experience, wishes responsible position in executive or research line. Opportunity for advancement essential. Not subject to selective service. PW-318, Met. & Chem. Engrg.

ELECTRICAL engineering graduate; eight years' experience drafting, industrial plant electrical layouts, conduit systems, construction. PW-320, Met. & Chem. Engrg.

ELECTRIC steel. Position wanted as manager or superintendent of foundry equipped with electric furnaces of any type or contemplating new installation. College education, several years' experience with electric steel. PW-272, Met. & Chem. Engrg., Chicago.

ELECTRO-Metallurgical Engineer. Experienced in the design, erection and operation of ferro alloy installations. Ferro silicon, manganese, chrome, tungsten and nickel. First class organizer and a producer. PW-287, Met. & Chem. Engrg., Philadelphia.

EXECUTIVE chemical engineer. Young man with ten years' experience as factory executive and engineer adapting processes to commercial conditions, will be open for engagement about August first. New York vicinity preperred. PW-329, Met. & Chem. Engrg.

FERRO Manganese. If you have the ore, the power and the capital I have the experience. Low grade ores a specialty. PW-288, Met. & Chem. Engrg., Philadelphia.

CHEMICAL ENGINEER

Ten years' experience in analytical, research, development and engineering of process work in large manufacturing plants. Had three years' experience in a plant for wood distillation with complete line of finished by-products; for the past four years in charge of process and maintenance department of large oil refinery. Open for responsible position in technical department of larger concern. Age 32, married, references. Minimum salary $3600.

PW328—Met. & Chem. Engrg.
1570 Old Colony Bldg., Chicago, Ill.

SEARCHLIGHT SECTION

POSITIONS WANTED

FERRO Tungsten—Electric Furnace. Have developed a process to make specification material at a cost of fifteen cents per pound tungsten exclusive ore. Will design, erect and operate plant for you or change your existing plant. PW-286, Met. & Chem. Engrg., Philadelphia.

MECHANICAL engineer with experience in handling chemical work desires change. Special knowledge of mechanical and combustion work of all kinds, including producer gas and oil fuel problems. College graduate with shop training. Responsible position desired. PW-273, Met. & Chem. Engrg., Philadelphia.

MECHANICAL engineer, graduate, wide experience in gas, chemical and industrial plant design and equipment, desires position in operating or construction department along similar lines. PW-316, Met. & Chem. Engrg.

METALLURGIST—Experienced in production of alloys of vanadium, molybdenum, tungsten, etc; directing chemical plants and solving chemical processes. Research work a specialty. Now superintending operation of chemical and ferro alloy plant. Permanent engagement with sound organization required. PW-314, Met. & Chem. Engrg., Chicago.

METALLURGICAL and Analytical Chemist 6 years' experience along general lines, 30 years old, single, desires change. Can take charge of laboratory. Deferred Classification. Least salary considered $1800. PW-325, Met. & Chem. Engrg., Philadelphia.

METALLURGIST with several years' experience with electric furnaces, at present employed, desires to change. PW-227, Met. & Chem. Engrg., Chicago.

METALLURGIST, with modern practice in refining copper, electrolytic slimes and rare metal precipitates, desires position as superintendent of such works. Speak Spanish and Russian. References furnished on request. PW-166, Met. & Chem. Engrg., Chicago.

PACIFIC Coast position wanted by Chemical engineer, 38, good technical training and experience. Moderate starting salary. PW-312, Met. & Chem. Engrg., San Francisco.

RESEARCH chemist, expert analyst, can reproduce products of any industry; twenty years' experience. PW-243, Met. & Chem. Engrg.

TECHNICAL graduate, age 29, class IV in the draft. Thoroughly experienced in the manufacture of nitro cellulose products, nitric acid and sulphuric acid. Will consider a responsible operating or laboratory position. PW-263, Met. & Chem. Engrg.

YOUNG chemical engineer experienced in executive and purchasing end of the oil business, in oil cracking, oil burning, and design of plants, now employed, wishes a new position. PW-304, Met. & Chem. Engrg., Philadelphia.

YOUNG CHEMIST—University graduate. Wishes to connect with a forward concern. Preferably one doing government work. Two years' experience in organic and inorganic analysis and research. PW-322, Met. & Chem. Engrg.

Get your Wants into the Searchlight

ADVERTISING RATES

Ads Set in Uniform Style

(Solid, in one paragraph, without display.)

THREE CENTS A WORD, minimum charge 30 cents an insertion, payable in advance, less 10 per cent if one payment is made in advance for four continuous insertions—for advertisements under:

Positions Wanted	Vacation Work Wanted
Evening Work Wanted	Tutoring
	Salesman Wants Connections

FIVE CENTS A WORD, minimum charge $1.50 an insertion, for advertisement under:

Agencies Wanted	Positions Vacant
Agents Wanted	Partner Wanted
Business Opportunities	Representations Wanted
Desk Room for Rent	Salesmen Wanted
Educational	Patents for Sale
Employment Agencies	Plants for Sale
Desk Room Wanted	Sub-Contracts Wanted
Foreign Business	Work Wanted

Miscellaneous for Sale, for Rent or Want Ads.

THIRTY CENTS A LINE, minimum five lines, for all undisplayed advertisements set with a paragraph for each item or tabulated.

THREE DOLLARS AND SIXTY CENTS AN INCH for advertisements for bids (Official Proposals).

Ads Set in Display Type

(Individual space, within border rules.)

Space for these advertisements is sold by the inch. Each page contains 27 inches. The rate per inch is based on the *total* number of inches to be used—that is, the number of inches the advertisement is to occupy multiplied by the number of insertions it is to receive. For instance, a 2-inch advertisement in 2 issues earns the 4-inch rate of $3.00 an inch. A 1-inch space in 4 issues, or a 4-inch space in one issue, also earn the 4-inch rate.

SCHEDULE OF RATES

1 to 3 in., $3.00 an in.	15 to 26 in., $2.70 an in.
4 to 7 in., 2.90 an in.	27 to 49 in., 2.60 an in.
8 to 14 in., 2.80 an in.	50 to 99 in., 2.55 an in.

Rates for larger space furnished on request.

INFORMATION

ALLOW FIVE WORDS for the address, if replies are to a box number in care of any of our offices. There is no extra charge for forwarding replies.

IN REPLYING TO ADS, do not enclose original testimonials or anything that you may want returned. State your experience and qualifications in as concise and neat a manner as possible and enclose copies of your testimonials.

BE CAREFUL TO PUT ON ENVELOPE, when answering any "blind" ad, the box number in the ad, the name of the paper, and also the local address of office to which reply is sent:

36th St., at 10th Ave.,	New York
1570 Old Colony Bldg.,	Chicago
657 Leader-News Bldg.,	Cleveland
935 Real Estate Trust Bldg.,	Philadelphia
501 Ria to Bldg.,	San Francisco

WHEN ADVERTISING MACHINERY, use your own name and address—or a local address of some kind—so that the readers can wire direct and get quick replies. We advise also that you state in your advertisement the present location of plant that is offered for sale, or point of delivery provided you are in the market for equipment.

TO SIGN YOUR NAME and address to your advertisement begets the confidence of the reader and facilitate receiving replies. You can however, obviate delay in receiving answers by signing your ad. only with initials (your own or others), care of your home, your office or a post-office box number in your city.

For quick and satisfactory results tell the reader everything that he will want to know

POSITIONS WANTED

YOUNG man, 23, at present employed, desires change with opportunity for advancement, where no experience is necessary, thorough chemistry training at I. C. S., proficient, industrious and capable. PW-315, Met. & Chem. Engrg.

AGENTS AND SALESMEN

Salesman Wanted

Men familiar with furnace and boiler operation and refractories to handle high grade furnace specialties. Location Eastern or Middle Pennsylvania, New York State, Connecticut or Indiana. Fine opportunity for right man. Salary and commission. AS-282, Met. & Chem. Engrg.

Salesman Wanted

A fertilizer salesman, exempt from draft, on animal based goods and maufacturer's profit. No capital required, competing competitor's prices; must have an established trade with large tonnage in New York, New Jersey, Delaware, Maryland, Pennsylvania and Long Island. AS-317, Met. & Chem. Engrg., Philadelphia.

EMPLOYMENT AGENCIES

THE ENGINEERING AGENCY, INC., established 25 years, is constantly in touch with positions in chemistry, chemical engineering and metallurgical work. Several men in these lines are needed for positions open at this time. Address Chemical Dept., 1662 Monadnock Block, Chicago, Ill.

OPERATING CHEMISTS WANTED. $1200-$1800. Office Service Employment Exchange, Singer Building, New York City.

CORRESPONDENCE SERVICE

The undersigned provides a confidential service designed to locate openings through correspondence for men earning not less than $2,500 and up to $25,000; all lines. Not an employment agency but a constructive, initiative service, covering individual negotiations. Established 1910. Complete privacy assured; present connections in no way jeopardized. Send name and address only for explanatory details. R. W. Bixby, D64, 66 Niagara St., Buffalo, N. Y.

Chemists Seeking Suitable Positions
and
Employers Seeking Suitable Chemists
write Julian M. Blair, Secretary
THE CHEMISTS' EMPLOYMENT BUREAU
Nashville, Tenn.
A successful bureau. Strictly confidential. No charge to employers. No initial expense to chemists.

IF YOU WANT PROOFS

of your advertisements, and time to return them with corrections

Copy Must Be in Our Hands Two Weeks in Advance of Publication Date

Copy Changes. If no proofs are desired your advertisements should be in our hands one week preceding date of publication, otherwise your latest advertisement in accordance with schedule will be repeated.

New Advertisements (not changes of copy) can usually be accepted up to four days preceding date of publication, but no guarantee can be given as to location or proofs or indexing.

Searchlight Advertisements (Proposals, Wants, For Sale, etc.) received as late as 10 A. M. the second day preceding date of publication will be published if there is space available in the pages that go to press last.

THESE are not arbitrary rules. We do our best to give our advertisers what they want—work overtime if necessary—but each advertising form has to be on the press at a specified time. That is why we cannot guarantee proof or location unless we have copy on time. We want our advertising space to work at maximum efficiency for our advertisers.

The Paper is published the 1st and 15th of each month

Metallurgical & Chemical Engineering

10th Ave. at 36th St., New York City

Josh Billings said:

"I luv the rooster for 2 things. For the crow that iz in him and for the spurs he has got to bak up the crow with."

All the arguments in the world wouldn't persuade so many people to use the "Want" and "For Sale" pages of **Metallurgical and Chemical Engineering** unless the paper showed results with which to back up the arguments.

Look at the Searchlight advertisements in this issue

THE DECEMBER ISSUE CONTAINS:

RADIOTELEGRAPHY AND RADIOTELEPHONY, by S. M. Kintner General Mgr., International Signal Company, Pittsburgh.

INDUSTRIAL HOUSING, by H. Walter Forster, General Mgr., Independence Bureau, Philadelphia, Pa.

THE JANUARY ISSUE CONTAINS:

THE SITUATION IN REGARD TO MANGANESE, SULPHUR, PYRITE AND SOME OTHER WAR MINERALS, by J. E. Johnson, Jr., Consulting Engineer and Metallurgist, New York, N. Y.

THE MANUFACTURE AND USE OF DIE CASTINGS, by Charles Pack, Chief Chemist and Metallurgist, Doehler Die-Casting Co., Brooklyn, N. Y.

THE FEBRUARY ISSUE CONTAINS:

THE DESIGN AND PROGRESS OF THE FLOATING FRAME REDUCTION GEAR, by John H. Macalpine, Member, Institute of Naval Architects, Pittsburgh, Pa.

THE FLAT SLAB SYSTEM (A Topical Discussion), T. L. Condron, Condron Co., Industrial and Structural Engineers, Chicago, Ill. C. A. P. Turner, C. A. P. Turner Co., Consulting Engineers, Minneapolis, Minn. Edward Godfrey, Engr., Robert W. Hunt Co., Pittsburgh, Pa.

PROCEEDINGS
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA
50 cents per copy, $5.00 per year.

KENNETH F. TRESCHOW, Secretary. 568 Union Arcade Bldg. Pittsburgh, Pa.

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We have a large stock of the best European acid washed, chemically pure and folded filters, also an excellent American paper for qualitative work.

SCIENTIFIC MATERIALS CO., PITTSBURGH, PA.

For bonding and repairing fire clay or silica brick work, tile, retorts, crucibles, etc.

USE **HYTEMPITE** THE

(Reg. U. S. Pat. Off.)

High Temperature Fire Brick Cement.

Quigley Furnace Specialties Co.

26 Cortlandt Street New York

Little "Want Ads" in the

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bring BIG results

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To Users of PLATINUM WARE

If you are in possession of any old, worn out or unused apparatus or platinum scrap, you can perform a truly patriotic service by disposing of the same promptly to us, where it will be used to the best advantage in the successful prosecution of the war.

The essential metals of the platinum group, recovered and purchased by us are entirely at the disposal of the government and will be manufactured into such forms as are required by the most essential industries, under the direction of the "War Industries Board."

BAKER & CO., INC.

Newark, New Jersey

New York Office, 30 Church Street

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used by the Chemical, Metallurgical and Allied Industries with Names of Manufacturers and Distributors

Acid Concentration Apparatus
Chemical Construction Co.
Duriron Castings Co.
International Glass Co., The
Kalbperry Corp., The
Pratt Eng. & Machine Co.
Thermal Syndicate, Ltd., The

Acid Distillation Apparatus
Buffalo Foundry & Machine Co.
Pratt Eng. & Mach. Co.
Thermal Syndicate, Ltd., The

Acid Eggs, Cast Iron
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.
Elyria Enameled Products Co.
Monarch Mfg. Works
Stearns-Roger Mfg. Co.
Stuart & Peterson Co.
U. S. Cast Iron Pipe & Fdry. Co.

Acid Eggs, Stoneware, Acid Proof
Knight, Maurice A.
Monarch Mfg. Works
Pratt Eng. & Mach. Co.
U. S. Stoneware Co.

Acid Resisting Glass Enameled Apparatus
See Enameled Apparatus, Acid Resisting

Acid Resisting Metals
Bario Metal Corp., The

Acid, Sulphuric
New Jersey Zinc Company, The

Acid Ware
See Enameled Ware, Glassware, Porcelain, Silica and Stoneware

Agitating Machinery
Caldwell, W. E., Co.
Werner & Pfleiderer Co., Inc.

Agitator Tanks, Wood
Baltimore Co., The
Pacific Tank & Pipe Co.
Schwarzwalder, J., & Sons, Inc.

Agitators
Dorr Co., The
General Machine Co.
U. S. Stoneware Co.
Werner & Pfleiderer Co., Inc.

Air Compressors
Ingersoll-Rand Company
Taylor Instrument Companies

Air Conditioning Apparatus
Braemer Air Conditioning Corp.
Carrier Engineering Corp.
Fleisher, W. L., & Co., Inc.
Spray Engineering Co.

Air Lift Pumping System
Ingersoll-Rand Company

Air Separators
See Separators, Air

Air Washers
American Blower Co.
Braemer Air Conditioning Corp.
Carrier Engineering Corporation

Alloys
See Ferro-Alloys

Alloys, Special
American Magnesium Corp.
Lavino, E. J., & Co.
Metal & Thermit Corp.
Norton Laboratories

Aluminum
Aluminum Company of America
Electric Smelt. & Alum. Co.

Amines
Newport Chemical Works, Inc.

Analytical Apparatus
Ainsworth, Wm., & Son
Bausch & Lomb Opt. Co.
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Buffalo Dental Mfg. Co.
Central Scientific Co.
Daigger, A., & Co.
Eimer & Amend
Hoskins Mfg. Co.
Mine & Smelter Supply Co.
Palo Company
Sargent, E. H., & Co.
Scientific Materials Co.
Thomas Co., Arthur H.

Analyzers, Gas and Automatic
Uehling Instrument Co.
Williams Apparatus Company

Asbestos Cloth, Yarn, Banding Tape and Fiber
Aspromet Company

Asbestos, Raw
Carolina, Clinchfield & Ohio Ry.

Ash Handling Machinery
Bartlett & Snow, The C. O., Co.
Guarantee Construction Co.
Jeffrey Mfg. Co.

Assayers
See Professional Directors, Pages 122, 123

Autoclaves
Buffalo Foundry & Machine Co.
Camden Iron Works
Devine, J. P., Co.
Ott, Geo. F., Co.
Stokes, F. J., Machine Co.
Valley Iron Works (Williamsport, Pa.)

Automatic Car Drive Systems
Pratt Eng. & Machine Co.

Automatic Scales
American Kron Scale Co.
Simmons, John, Company
Werner & Pfleiderer Co., Inc.

Automatic Skip Hoist Controllers
Cutler-Hammer Mfg. Co.

Balances and Weights
Ainsworth, Wm., & Sons
American Kron Scale Co.
Bausch & Lomb Opt. Co.
Braun Corperation, The
Braun-Knecht-Heinmann Co.
Central Scientific Co.
Eimer & Amend
Gaertner, Wm., & Co.
Laboratory Supply Co.
Lenz Apparatus Co.
Mine & Smelter Supply Co.
Palo Company
Schaar & Co.

Ball Mills
See Mills, Ball, Pebble, Tube

Barometric Condensers
Ingersoll-Rand Company

Barrel Racks, Steel
Economy Engineering Co.

Barrels, Steel, Bilge, Agitator and Open Head
Detroit Range Boiler Co.

Baskets, Dipping
Newark Wire Cloth Co.

Bauxite
Laclede-Christy Clay Products Co.
Lavino, E. J., & Co.

Belt Conveyors
Barber-Green Company
Bartlett & Snow, The C. O., Co.
Caldwell, H. W., & Son Co.
Jeffrey Mfg. Co.
Link-Belt Company
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Webster Mfg. Co., The

Belts, Conveying & Elevating
Goodrich, The B. F., Rubber Co
Smith Engineering Works

Bins, Steel and Concrete
Brown Hoisting Machinery Co.

Bleaching Powder
Electro-Bleaching Gas Co.

Blowers, Fan or Positive Pressure
Abbé Engineering Co.
American Blower Co.
Beach-Russ Company
Buffalo Forge Co.
Clarage Fan Co.
Connersville Blower Co.
Nash Engineering Co.

Blowers, Flotation
Connersville Blower Co.
Nash Engineering Co.

Boiler Coverings
Magnesia Association of America

Boilers, Water Tube
Vogt, Henry, Machine Co.

Bolting Cloths, Silk
Abbé Engineering Co.
Abbé, Paul O.

Bone Meal Grinders
American Pulverizer Co.

Books
McGraw-Hill Book Company

Brick, Acid Proof
Chemical Construction Co.
General Ceramics Co.
Harbison-Walker Refractories Co.
Hydraulic-Press Brick Co.
Laclede-Christy Clay Products Co.
Mine & Smelter Co.

Brick, Carborundum
Carborundum Co.

Brick, Chrome
Harbison-Walker Refractories Co.

Brick, Chrome, Raw Materials for
Carolina, Clinchfield & Ohio Ry.

Brick Insulating
Armstrong Cork & Insulation Co.
Celite Products Co.

Brick, Silica
Harbison-Walker Refractories Co.
Laclede-Christy Clay Products Co.

Brick, Silica, Raw Materials for
Carolina, Clinchfield & Ohio Ry.

Bronze, Titanium Aluminum
Titanium Alloy Mfg. Co., Inc.

Brushes, Carbon
National Carbon Co.

Buckets, Clamshell & Drag Line
Brown Hoisting Machinery Co.

Bucket Elevators
Bartlett & Snow, The C. O., Co.
Caldwell, H. W., & Son Co.
Jeffrey Mfg. Co.
Link-Belt Company
Stephens-Adamson Mfg. Co.
Webster Mfg. Co., The

Bunsen Burners
Detroit Heating & Lighting Co.

Burners, Gas and Oil
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Foundry Equipment Co., The
Mine & Smelter Supply Co.
Monarch Mfg. Works
Rockwell, W. S., Co.

Burners, Powdered Coal
Locomotive Pulverized Fuel Co.
Powdered Coal Eng. & Eqpt. Co.
Quigley Furnace Spec. Co.

Burners, Sulphur
Glens Falls Machine Co.
Pratt Eng. & Machine Co.
Valley Iron Wks. (Appleton, Wis.)

Cabinets, Laboratory
Schwartz Sectional System

Calorimeters
Central Scientific Co.
Gaertner, Wm., & Co.
Sargent, E. H., & Co.
Taylor Instrument Companies
Thomas, Arthur H., Co.

Carbons, Battery
National Carbon Co.

Carbons, Resistance
National Carbon Co.

Cars, Industrial
Easton Car & Construction Co.

Cascade Basins, Acid Proof
Acid Proof Iron Products Co.
Duriron Casting Co.
Thermal Syndicate, Ltd., The

Casseroles
Guernsey Earthenware Co.
Herold China & Pottery Co.
Ohio Pottery Co.

Castings, Acid Proof
Acid Proof Iron Products Co.
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Mach. Co.
Duriron Casting Co.
Pacific Foundry Co.
U. S. Cast Iron Pipe & Fdry. Co.

Castings, Bronze & Brass
Acid Proof Iron Products Co.
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Mach. Co.
Duriron Casting Co.
Jacoby, Henry E.
Lehigh Car Wheel & Axle Works
Lunkenheimer Co., The
Pacific Foundry Co.
Phoenix Iron Works Co.
Pratt Eng. & Mach. Co.
Sperry, D. R., & Co.
Valley Iron Works

Castings, Iron
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Castings, Lead
Craig Foundry Co.

Castings, Monel Metal
Supplee-Biddle Hdwe. Co.

Castings, Pure Copper
Titanium Alloy Mfg. Co., Inc.

Castings, Silicon
Carborundum Co.

Castings, Special and Chilled
Phoenix Iron Works Co.
U. S. Cast Iron Pipe & Fdry. Co.

Caustic Pots
See Pots, Cast Iron, Acid Proof

Caustic Soda and Chlorine Liquid
Electro-Bleaching Gas Co.

Caustic Soda and Chlorine
Electrolytic Cells for Making
Bleach Process Co.
Electro Chemical Co., The
Electrolytic Engineering Corp.
Electron Chemical Co.
Warner Chemical Co.

Causticizing Apparatus
Dorr Co., The
Scott, Ernest, & Co.
Zaremba Co.

Cement, Acid Proof
Anti-Hydro Waterproofing Co.

Cement Cloth
Ludlow-Saylor Wire Co., The

Cement, Furnace
Dixon, Jos., Crucible Co.
Quigley Furnace Specialties Co.

Centrifuges
Schaum & Uhlinger, Inc.
Sharples Specialty Co.
Tolhurst Machine Works

Chain Doors
Codd, E. J., Co.

Chemical Apparatus
See Acid Eggs, Castings Chemical, Distilling Machinery and Apparatus, Drying Machinery and Apparatus, Enameled Apparatus, Evaporators, Filter Presses, Glassware, Separators, Centrifugal, Stoneware, etc.

Chemical Cabinets
Schwartz Sectional System

Chemical Engines
American La France Fire Engine Co.

Chemical Equipment, Ultra Violet Ray
R. U. V. Company, The

Chemical Stoneware
See Stoneware, Chemical

Chemicals
Baker, J. T., Chem. Co.
Barrett Co., The
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Daigger, A., & Co.
du Pont de Nemours, E. I., & Co.
Eimer & Amend
General Chemical Co.
Heil, Henry Chemical Co.
Kauffman-Lattimer Co., The
Laboratory Apparatus Co., Pittsburgh
Lenz Apparatus Co.
Marden, Orth & Hastings Corp.
Merck & Co.
Mine & Smelter Supply Co., The
Research Laboratory of Chicago
Roessler & Hasslacher Chemical Co., The
Sargent, E. H., & Co.
Schaar & Co.
Scientific Materials Co.

Chemicals, Raw Materials for
Carolina, Clinchfield & Ohio Ry.

Chemists, Manufacturing
Baker, J. T. Chem. Co.
Merck & Co.
Newport Chemical Works
Research Laboratory of Chicago
Roessler & Hasslacher Chemical Co., The

Chemists and Chem. Engrs.
Maywald, Fred'k J.
See also Professional Directory, Pages 122, 123

Chlorine, Liquid
See Caustic Soda and Chlorine

Chrome Ore
Lavino, E. J. & Co.

Classifiers
Colorado Iron Works Co.
Dorr Co., The
Worthington Pump & Mach. Corp.

WHAT AND WHERE TO BUY

Clay, Fire
Carolina, Clinchfield & Ohio Ry.

Clay Goods
See Brick and Clay, also Porcelain Ware, also Stoneware, Chemical

Cloth, Carborundum and Alexite
Carborundum Co.

Coal Tar Pitch
Barrett Co., The

Coal Tar Products
Newport Chemical Works., Inc.

Cocks, Cast Iron, Acid Proof
See Valves and Cocks, Cast Iron, Acid Proof

Cocks, Stoneware, Acid Proof
See Valves and Cocks, Stoneware, Acid Proof

Coils, Copper
Badger, E. B. & Sons Co.
Lummus, The W. E. Co.
Swenson Evaporator Co.
Werner & Pfleiderer Co.
Zaremba Co.

Coil Pipe
Simmons, John, Company
Whitlock Coil Pipe Co.

Coils & Worms, Stoneware
See Stoneware, Chemical

Color Testing Equipment, Ultra Violet Ray
R. U. V. Company, The

Combustion Boats
Engelhard, Chas.

Compressors, Air or Gas
Crowell Mfg. Co.
Nash Engineering Co.

Concentrating Tables
Mine & Smelter Supply Co., The

Concrete Hardening Compound (Liquid)
Anti-Hydro Waterproofing Co.

Condenser, Barometric, Surface or Jet
Buffalo Fdry. & Mach. Co.
Connersville Blower Co.
Devine Co., J. P.
Stokes, F. J., Machine Co.

Connectors, Frankel Solderless
Westinghouse Elect. & Mfg. Co.

Controllers, Temperature
Powers Regulator Co., The

Converters, Rotary
Lincoln Electric Co., The

Conveying Machinery
See Machinery, Elevating and Conveying

Conveyor Belts
Goodrich, The B. F., Rubber Co.

Conveyors, Portable
Barber-Greene Company
Jeffrey Mfg. Co.

Cooling Cylinders
Brecht Company, The

Coppersmithing
Badger, E. B., & Sons Co.
Lummus, The Walter E., Co.
Ott, George F., Co.

Crane and Hoist Controllers
Cutler-Hammer Mfg. Co.

Cranes
Brown Hoisting Machinery Co.

Cranes, Locomotive
Link-Belt Company

Crucibles
Acid Proof Iron Products Co.
Bario Metal Corp., The
Buffalo Dental Mfg. Co.
Duriron Castings Co.
Guernsey Earthenware Co.
Mine & Smelter Supply Co., The
Thermal Syndicate, Ltd., The

Crucibles, Clay
Denver Fire Clay Co.

Crucibles, Graphite
Acheson Graphite Co.
Bartley, Jonathan, Crucible Co.
Dixon, Jos., Crucible Co.

Crucibles, Nickel
Driver-Harris Company

Crushers, Grinders and Pulverizers
See Machinery, Crushing, Grinding and Pulverizing

Crushers, Grdrs., Pulv., Lab.
See Machinery, Crushing, Grinding and Pulverizing Laboratory

Crystallizing Dishes & Pans, Stoneware
See Stoneware, Chemical

Crystallizing Pans, Cast Iron
Buffalo Foundry & Machine Co.
Devine Co., J. P.
Pfaudler Company

Cupels
Dixon, Jos., Crucible Co.

Curb Boxes, Meter
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Cyanide
Roessler & Hasslacher Chem. Co.

Cyanide Machinery
See Machinery, Cyanide

Cyanide Tanks
Baltimore Co., The

Die Castings (Bronze)
Titanium Alloy Mfg. Co., Inc.

Diffusion Batteries
Blair, Campbell & McLean, Ltd.
Lummus, The W. E. Co.
Swenson Evaporator Co.

Digesters
Brecht Company, The
Elyria Enameled Products Co.
Manitowoc Engineering Works
Stuart & Peterson Co.
Swenson Evaporator Co.

Disintegrators
Abbé, Paul O.
Jeffrey Mfg. Co.
Stedman's Fdry. & Mach. Works

Distillation, Hardwoods for
Carolina, Clinchfield & Ohio Ry.

Distilling Machy. and Apparatus
Badger, E. B. & Sons Co.
Blair, Campbell & McLean, Ltd.
Carbondale Machine Co., The
Detroit Heating & Lighting Co.
Devine Co., J. P.
Duriron Castings Co.
Elyria Enameled Products Co.
Isbell-Porter Co.
Koven, L. O., & Bro.
Lummus, The W. E., Co.
Ott, George F., Co.
Pfaudler Co., The
Scott, Ernest, & Co.
Stevens-Aylsworth Co.
Stokes, F. J., Machine Co.
Thomas Co., Arthur H.
Stuart & Peterson Co.
Swenson Evaporator Co.
Zaremba Co.

Door Screens
Codd, E. J., Co.

Drop Forge Fittings
Simmons, John, Company
Vogt, Henry, Machine Co.

Drums, Steel
Detroit Range Boiler Co.

Dry Blast Plants
Carrier Engineering Corporation

Dry Cell Filler
Acheson Graphite Co.

Dryers, Centrifugal
Elmore, G. H.
Schaum & Uhlinger, Inc.
Sharples Specialty Co.
Tolhurst Mach. Works

Dryers, Vacuum
Buffalo Foundry & Machine Co.
Devine, J. P., Co.
Jacoby, Hy. E.
Scott, Ernest, & Co.
Sowers Mfg. Co.
Stokes, F. J. Machine Co.

Drying Mach. & Apparatus
American Blower Co.
American Process Co.
Bartlett & Snow, The C. O., Co.
Brecht Company, The
Buffalo Foundry & Machine Co.
Buffalo Forge Co.
Clarage Fan Co.
Devine Co., J. P.
Fleisher, W. L., & Co., Inc.
Gordon Engineering Corp.
Koven, L. O., & Bro.
Manitowoc Engineering Works
Philadelphia Textile Mach Co.
Ruggles-Coles Eng. Co.
Scott, Ernest, & Co.
Stearns-Roger Mfg. Co.
Stokes, F. J., Machine Co.
Swenson Evaporator Co.
Vulcan Iron Works

Dust Collecting Systems & Engineers
Clark Dust Collecting Co.
Paxson, J. W., Co.
Pratt Eng. & Machine Co.
Raymond Bros. Imp. Pul. Co.
U. S. Blow Pipe & Dust Collecting Co.
Williams Patent Crusher & Pulverizer Co.

Dyes and Dyestuffs
du Pont de Nemours, E. I., & Co.
Marden, Orth & Hastings Corp.

Dyes, Raw Materials for
Carolina, Clinchfield & Ohio Ry.

Dynamite
du Pont de Nemours, E. I., & Co.

Dynamos, Electroplating
See Electroplating Dynamos, Supplies

Dynamos and Motors
Bogue, C. J., Elect. Co.
Jantz & Leist Elec. Co.
Lincoln Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Cranes
See Cranes

Electric Furnaces
See Furnaces, Electric

Electric Furnaces, Laboratory
See Furnaces, Elec. Lab'y

Electrical Testing Sets
Weston Electrical Inst. Co.

Electrodes, Carbon
Acheson Graphite Co.
National Carbon Co.

Electrolytic Cells
Bleach Process Co.
Electro Chemical Company, The
Electrolytic Eng. Corp.
Electrolytic Oxy-Hydrogen Lab., Inc.
Electron Chemical Co.
Warner Chemical Co.

Electrolytic Oxygen and Hydrogen Generators
Electrolytic Oxy-Hydrogen Lab., Inc.

Electrolytic Salts
Roessler & Hasslacher Chem. Co.

Electroplating Dynamos: Supplies
Bogue, C. J., Elect. Co.
Jantz & Leist Elect. Co.

Elevating and Conveying Machinery
See Machinery, Conveying and Elevating

Elevators, Revolving Portable
Economy Engineering Co.
N. Y. Revolving Portable Elevator Co.
Revolvator Co.

Enameled Apparatus, Acid Resisting
Elyria Enameled Products Co.
Pfaudler Co., The
Stearns-Roger Mfg. Co.
Stuart & Peterson Co.

Engineers, Chemical, Consulting, Analytical, Industrial
Also see Professional Directory, pages 122, 123
American Industrial Eng. Co.
Clark Dust Collecting Co.
W. L. Fleisher & Co.
General Machine Co., Inc.
Hercules Eng. Corp.
Kalbperry Corp., The
Locomotive Pulverized Fuel Co.
Maywald, Fred'k J.
Powdered Coal Eng. & Equipment Co.
Pratt Eng. & Machine Co.
Research Laboratory of Chicago.
Southwestern Engineering Co.
Uehling Instrument Co.
Williams Apparatus Company

Engineers, Combustion
Improved Equipment Co.
Locomotive Pulverized Fuel Co.
Steere Eng. Co.
Uehling Instrument Co.

Engineers' Construction
Cannon-Swenson Co.
Chemical Construction Co.
Green, Samuel M., Co.
Guarantee Construction Co.
Hercules Eng. Corp.
Research Laboratory of Chicago
Southwestern Engineering Co.

Engineers, Furnace
Hagan, Geo. J., Co.
Rockwell, W. S., Co.
Russell Engineering Company

Engineers, Pyrometric
Holz, Herman A.

Engines, Steam and Hauling
Vulcan Iron Works

Evaporating Dishes
Guernsey Earthenware Co.
Knight, Maurice A.
Thermal Syndicate, Ltd., The
U. S. Stoneware Co.

Evaporators
Allbright-Nell Co., The
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Ltd.
Brecht Company, The
Buffalo Fdry. & Mach. Co.
Camden Iron Works
Devine, J. P., Co.
Jacoby, Henry E.
Kestner Evaporator Co.
Koven, L. O., & Bro.
Lummus, The W. E., Co.
Ott, Geo. F., Co.
Pfaudler Co., The
Pratt Eng. & Machine Co.
Scott, Ernest, & Co.
Sowers Manufacturing Co.
Sperry, D. R., & Sons
Stokes, F. J., Machine Co.
Swenson Evaporator Co.
Zaremba Co.

Explosives
du Pont de Nemours, E. J., & Co.

Extract, Tannin, Woods for
Carolina, Clinchfield & Ohio Ry.

Extracts
Marden, Orth & Hastings Corp.

Extractors
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Ltd.
Devine, J. P., Co.
Koven, L. O., & Bro.
Lummus, The W. E., Co.
Ott, Geo. F., Co.

Extractors, Centrifugal
Schaum & Uhlinger, Inc.
Sharples Specialty Co.
Tolhurst Machine Works

Fans
Buffalo Forge Co.
Clarage Fan Co.
Philadelphia Textile Mach. Co.
Pratt Eng. & Machine Co.
Raymond Bros. Impact Pulv. Co.
Stearns-Roger Mfg. Co.
Williams Patent Crusher & Pulv. Co.

Fans, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Faucets, Stoneware, Acid Proof
See Stoneware, Chemical

Feeders
American Pulverizer Co.
Bartlett & Snow, The C. O., Co.
Jeffrey Mfg. Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Webster Mfg. Co., The

Fences, Chain Link
Anchor Post Iron Works

Fences, Rail
Anchor Post Iron Works

Fences, Unclimbable, Factory
Anchor Post Iron Works

Ferro-Alloys
Continuous Reaction Co., The
Ferro-Alloy Co., The
Lavino, E. J., & Co.
Leavitt, C. W., & Co.
Metal & Thermit Corp.
Standard Alloys Co.
Titanium Alloy Mfg. Co.

Ferro-Alloys, Raw Materials for
Carolina, Clinchfield & Ohio Ry.

Ferro-carbon—Titanium
See Titanium

Ferro-Chrome
Lavino, E. J., & Co.

Ferro-Manganese
Lavino, E. J., & Co.

Ferro-Silicon
Lavino, E. J., & Co.

Ferro-Tungsten
Lavino, E. J., & Co.

Fibre Products
Diamond State Fibre Co.

Filing Cabinets
Schwartz Sectional System

Filter Cloth
Huyck, F. C. & Sons

Filter Cloth (Metallic)
Multi-Metal Separating Screen Co.
Newark Wire Cloth Co.
Supplee-Biddle Hardware Co.
Tyler, The W. S., Co.
United Filters Corp.

Filter Paper
Angel, H. Reeve, & Co.
Elmer & Amend
Laboratory Supply Co., The

Filter, Porous Porcelain
Herold China & Pottery Co.

Filter Presses
Allbright-Nell Co., The
American Continuous Filter Co.
Brecht Company, The
Burger, Alfred & Co.
Colorado Iron Works Co.
Independent Filter Press Co.
Industrial Filtration Corporation
Jacoby, Henry E.
Johnson, John Co.
Kelly Filter Press Co.
Koven, L. O., & Bro.
Lungwitz, E. E.
Oliver Continuous Filter Co.
Patterson Fdry. & Mach. Co.
Perrin, Wm. F., & Co.
Shriver, T., & Co.
Sperry, D. R., & Co.
Sweetland Filter Press Co.

Filter Press Distil'y Grains
Swenson Evaporator Co.

Filter Press Parts
Agitators, Gears, Pumps
Independent Filter Press Co.

Filtering Media
Celite Products Co.
Colwell, Lewis

Filters
Colwell, Lewis
Hungerford & Terry, Inc.

Filters, Laboratory
Perrin, Wm. R., & Co.

Filters, Rotary Continuous
American Continuous Filter Co.
Chalmers & Williams
Colorado Iron Works Co.
Industrial Filtration Corp.
Kelly Filter Press Co.
Oliver Continuous Filter Co.
Southwestern Engineering Co.
Sweetland Filter Press Co.

WHAT AND WHERE TO BUY

Filters, Suction, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.

Fire Brick and Clay
See Brick and Clay, Fire

Fire Extinguishers
American-La France Fire Engine Co.

Fire, Sand, Carborundum
Carborundum Co.

Fireproof Building Materials
Aspromet Company

Floors & Pits, Acid Resisting
Anti-Hydro Waterproofing Co.

Flotation Apparatus
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Colorado Iron Works
Pensacola Tar & Turpentine Co.
Southwestern Eng. Co.

Flotation Oil
Pensacola Tar & Turpentine Co.

Fluorspar
Lavino, E. J., & Co.

Foundry Supplies & Equipment
Electric Smelting & Alum. Co.
Paxson Co., J. W.

Fuel Economizer
Magnesia Assn. of America

Furnace Cement
See Cement, Furnace

Furnace Engineers
See Engineers, Furnace

Furnace Facings & Linings
Acheson Graphite Co.
Celite Products Co.
Dixon, Jos., Crucible Co.
Laclede-Christy Clay Products Co.
Quigley Furnace Specialties Co.

Furnace Hoists
Brown Hoisting Machinery Co.

Furnaces, Assay
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Mine & Smelter Supply Co.

Furnaces, Brass and Aluminum Melting
Foundry Equipment Co., The

Furnaces, Chloridizing and Sulphating
Wedge Mechanical Furnace Co.

Furnaces, Cupola, Foundry
Worthington Pump & Mach. Corp.

Furnaces, Electric, Lab'y
Bario Metal Corp., The
Brown Instrument Co., The
Central Scientific Co.
Electric Htg. Apparatus Co.
Engelhard, Chas.
Hoskins Mfg. Co.

Furnaces, Heat Treating
Brown Instrument Co., The
Electric Htg. Apparatus Co.
Engelhard, Chas.
Hagan, Geo. J., Co.
Hoskins Mfg. Co.
Rockwell, W. S., Co.
Russell Engineering Co.
Wedge Mechanical Furnace Co.

Furnaces, Melting:
Oil, Gas or Powdered Coal
Hagan, Geo. J., Co.
Rockwell, W. S., Co.
Russell Engineering Company

Furnaces, Muffle
Denver Fire Clay Co.
Electric Htg. Apparatus Co.
Hoskins Mfg. Co.
Improved Equipment Co.
Russell Engineering Company
Wedge Mechanical Furnace Co.

Furnaces, Roasting and Smelting
Allis Chalmers Mfg. Co.
Colorado Iron Works Co.
General Chemical Co., The
Pacific Foundry Co.
Russell Engineering Company
Wedge Mechanical Furnace Co.

Furnaces, Sulphur
General Chemical Co., The
Pacific Foundry Co.
Pratt Eng. & Machine Co.
Schutte & Koerting Co.
Wedge Mechanical Furnace Co.

Fused Silica
Thermal Syndicate, Ltd., The

Gas Furnaces
See Furnaces, Gas

Gas Machines
Detroit Heating & Lighting Co.

Gas Producers
Camden Iron Works
Chapman Eng. Co.
Flinn & Dreffein Co.
Hagan, Geo. J., Co.
Improved Equipment Co.
Morgan Const. Co.
Smith Gas Engineering Co., The

Gas Pumps and Exhausters
See Pumps, Gas, Liquid or Vacuum

Gas Scrubbers and Washers
Buffalo Forge Co.

Gaskets
Sarco Company, Inc.

Gates, Iron & Wire
Anchor Post Iron Works

Gauges, Recording, Indicating, Draft, Pressure
Bristol Co., The
Brown Instrument Co.
Foxboro Co.
Pneumercator Co., Inc.
Taylor Instrument Companies
Thwing Instrument Co.
Uehling Instrument Co.

Gears
Caldwell, H. W., & Son Co.

Generators
See Dynamos and Motors

Generators (Oxygen and Hydrogen)
Electrolytic Oxy-Hydrogen Lab., Inc.

Glass Blowing
Central Scientific Co.
International Glass Co.
Kaufman-Lattimer Co., The
Laboratory Supply Co.
Lenz Apparatus Co.
Scientific Materials Co.

Glassware, Chemical
Flasks, Breakers, Crystallising Dishes, Hydrometer Jars, Petri Dishes, etc.
Central Scientific Co.
Eimer & Amend
Griebel, Instrument Co.
Heil, H., Chemical Co.
International Glass Co., The
Laboratory Supply Co., The
Macbeth-Evans Glass Co., The
Mine & Smelter Supply Co., The

Glassware, Raw Materials for
Carolina, Clinchfield & Ohio Ry.

Glazing Construction
Aspromet Company

Graphite
Acheson Graphite Co.

Grinders
See Machinery, Crushing, Grinding and Pulverizing

Hardness Testers
Holz, Herman A.

Heat Insulation
Magnesia Assn. of America

Heaters, Feed Water
Braemer Air Conditioning Corp.

Heating Apparatus and Systems
American Blower Co.
Braemer Air Conditioning Co.
Buffalo Forge Co.
Clarage Fan Co.
Powers Regulator Co., The
Ruggles-Coles Eng. Co.
Sarco Co., Inc.

Heating Regulators
Powers Regulator Co., The

Hoists
Brown Hoisting Machinery Co.

Hoisting Machinery, Special
Economy Engineering Co.

Hose, all kinds
Goodrich, The B. F. Co.

Hoists, Portable Platform
Economy Engineering Co.

Hydraulic Machinery
Hydraulic Press Mfg. Co., The

Hydraulic Presses
Hydraulic Press Mfg. Co., The

Hydro-Electric Power
Carolina, Clinchfield & Ohio Ry.

Hydrogen Generating Apparatus
Electrolytic Oxy-Hydrogen Lab., Inc.
Improved Equipment Co.

Hydrometers
Brown Instrument Co., The
Griebel Instrument Co.

Hypochlorite Cells
Electro Chemical Co.

Impregnating Apparatus
Devine, J. P., Co.

Instruments, Electrical and Testing
Bristol Co., The
Brown Instrument Co.
Central Scientific Co.
Eimer & Amend
Hoskins Mfg. Co.
Precision Ther. & Inst. Co.
Pyroletric Instrument Co.
Shore Instrument Co.
Stupakoff Laboratories
Thwing Instrument Co.
Uehling Instrument Co.
Westinghouse Electric & Mfg. Co.
Weston Electrical Instrument Co.

Insulating Material, Electric
Redmanol Chemical Products Co.

Insulating Material, Heat
Armstrong Cork & Insulation Co.
Carolina, Clinchfield & Ohio Ry.
Celite Products Co.
General Bakelite Co.
Magnesia Association of America

Intermediates
Marden, Orth & Hastings Corp.
Newport Chemical Works, Inc.

Iron and Steel Corrugated
Aspromet Company

Jigs
Worthington Pump & Mch. Corp.

Kettles, Cast Iron Acid Proof
Acid Proof Iron Products Co.
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Machine Co.
Devine, J. P., Co.
Duriron Castings Co.
Pacific Foundry Co.
Sowers Manufacturing Co.
Stevens-Aylsworth Company
U. S. Cast Iron Pipe & Fdry. Co.

Kettles, Enameled, Acid Proof
Elyria Enameled Products Co.
Pfaudler Co., The
Stuart & Peterson Co.

Kettles, Steam Jacketed
Buffalo Fdy. & Machine Co.
Detroit Heating & Lighting Co.
Devine Co., J. P.
Duriron Castings Co.
Elyria Enameled Products Co.
Koven, L. O., & Bro.
Ott, George F., Co.
Pfaudler Company, The
Pratt Eng. & Machine Co.
Stuart & Peterson Co.

Kettles, Stoneware, Acid Proof
See Stoneware, Chemical

Kiln, Lime
Improved Equipment Co.
Vulcan Iron Works

Kiln, Rotary & Nodulizing
American Process Co.
Colwell, Lewis
Ruggles-Coles Eng. Co.
Vulcan Iron Works

Laboratories, Chemical and Physical
Maywald, Fred'k. J.

Laboratory Apparatus and Supplies
Bausch & Lomb Optical Co.
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Buffalo Dental Mfg. Co.
Central Scientific Co.
Daigger, A., & Co.
Denver Fire Clay Co.
Detroit Heating & Lighting Co.
Eimer & Amend
Gaertner, Wm., & Co.
Guernsey Earthenware Co.
Heil, Henry, Chemical Co.
Hoskins Mfg. Co.
International Glass Co.
Kauffman-Lattimer Co., The
Lalor, William M.
Lenz Apparatus Co.
Mine & Smelter Supply Co., The
Multi-Metal Separating Screen Co.
Ohio Pottery Co.
Palo Company
Pyroletric Instrument Co.
Sargent, E. H., & Co.
Scharr & Co.
Scientific Materials Co.
Thomas Co., Arthur H.
Werner & Pfleiderer Co., Inc.

Lamp, Arc, & Incandescent, Tungsten
Holz, H. A.

Lead Burners
American Lead Burning Corp.

Leaded inc Oxide
New Jersey inc Company, The

Lifting Magnets
Cutler-Hammer Mfg. Co.

Lifts, Air Jet
Bethlehem Fdy. & Mach. Co.
Schutte & Koerting Co.

Lithopone
New Jersey Zinc Company, The

Loaders, Bucket
Barber-Greene Company

Locomotive Cranes
Brown Hoisting Machinery Co.

Locomotives, Industrial
Fate, J. D. Co.
Jeffrey Mfg. Co.
Vulcan Iron Works

Machinery, Agitating
Abbé, Paul O.
Dorr Co., The
Gedge-Gray Co., The
Stokes, F. J., Machine Co.

Machinery, Automatic Weighing
American Kron Scale Co.
Schaffer Eng. & Equipment Co.
Simmons, John, Company

Machinery, Classifying
Dorr Co., The

Machinery, Coal Grinding
Abbé, Paul O.
Aero Pulverizer Co.
American Pulverizer Co.
Jeffrey Mfg. Co.
Powdered Coal Eng. & Equpt. Co.
Pratt Eng. & Machine Co.
Raymond Bros. Impt. Pulv. Co.
Williams Patent Crusher & Pulv. Co.

Machinery, Conveying & Elevating
Bartlett & Snow, The C. O., Co.
Caldwell, H. W., & Son Co.
Guarantee Construction Co.
Jeffrey Mfg. Co.
Link-Belt Company
Monarch Mfg. Works
Robins Conveying Belt Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Webster Mfg. Co., The

Machinery, Crushing, Grinding and Pulverizing
Abbé Eng'g Co.
Abbé, paul O.
Aero Pulverizer Co.
Allis-Chalmers Mfg. Co.
American Pulverizer Co.
Bartlett & Snow, The C. O., Co.
Bradley Pulverizer Co
Buchanan, C. G. & Co.
Chalmers & Williams
Colorado Iron Works Co.
Denver Fire Clay Co.
Excelsior Tool & Machine Co.
Hardinge Conical Mill Co.
Jeffrey Mfg. Co.
K-B Pulverizer Co.
Kent Mill Co.
Mead & Company
Mine & Smelter Supply Co.
Patterson Fdy. & Mach. Co.
Pratt Eng. & Machine Co.
Raymond Bros. Imp. Pulv. Co.
Smith Engineering Works
Stedman's Foundry & Mach. Wks.
Sturtevant Mill Co.
Vulcan Iron Works
Williams Patent Crusher & Pulverizer Co.
Worthington Pump & Mchy. Corp.

Machinery, Crushing, Grinding & Pulverizing Lab'y
Abbé, Eng'g Co.
Abeé, Paul O.
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Central Scientific Co.
Chalmers & Williams
Hardinge Conical Mill Co.
Jeffrey Mfg. Co.
Sturtevant Mill Co.
Thomas Co., Arthur H.

Machinery, Cyanide
Allis-Chalmers Mfg. Co.
Colorado Iron Works Co.
Dorr Co., The
Worthington Pump & Mchy. Corp.

Machinery, Electrical
Lincoln Electric Co., The

Machinery, Metallurgical and Mining
Abbé, Eng'g Co.
Abbé, Paul O.
Aero Pulverizer Co.
Allis-Chalmers Mfg. Co.
American Continuous Filter Co.
American Process Co.
Chalmers & Williams
Colorado Iron Works Co.
Dorr Co., The
Dwight & Lloyd Sintering Co.
Excelsior Tool & Machine Co.
General Chemical Co., The
Hardinge Conical Mill Co.
Huff Electrostatic Separator Co.
Kelly Filter Press Co.
Kent Mill Co.
Lungwitz, E. E.
Mine & Smelter Supply Co., The
Pacific Foundry Co.
Raymond Bros. Imp. Pulv. Co.
Ruggles-Coles Eng. Co.
Stearns-Roger Mfg. Co.
Sturtevant Mill Co.
Sweetland Filter Press Co.
Tyler, The W. S., Co.
Vulcan Iron Works
Wedge Mechanical Furnace Co.
Worthington Pump & Mchy. Corp.

Machinery, Mixing and Kneading
Abbé Eng'g Co.
Abbé, Paul O.
Buffalo Fdy. & Machy. Co.
Gedge-Gray Co., The
Mead & Company
Patterson Fdy. & Mach. Co.
Pratt Eng. & Machine Co.
Sowers Manufacturing Co.
Stokes, F. J., Machine Co.
Worthington Pump & Mchy. Corp.

Machinery, Ore and Coal Handling
Barber-Greene Company
Bartlett & Snow, The C. O., Co.
Brown Hoisting Machinery Co.
Guarantee Construction Co.

Jeffrey Mfg. Co.
Link-Belt Company
Smith Engineering Works
Stephens-Adamson Mfg. Co.

Machinery, Ore Concentrating
Allis-Chalmers Mfg. Co.
Chalmers & Williams
Colorado Iron Works
Dorr Co., The
Kent Mill Co.
Ruggles-Coles Eng. Co.
Mine and Smelter Supply Co.
Worthington Pump & Mchy. Corp.

Machinery, Pipe Bending
American Pipe Bending Mach. Co.

Machinery, Refrigerating
Brecht Company, The
Carbondale Machine Co., The
Vogt, Henry, Machine Co.

Machinery, Screening
Allis-Chalmers Mfg. Co.
Bartlett & Snow, The C. O., Co.
Chalmers & Williams
Jeffrey Mfg. Co.
Link-Belt Company
Stephens-Adamson Mfg. Co.
Smith Engineering Works
Tyler, The W. S., Co.
Webster Mfg. Co., The
Worthington Pump & Mchy. Corp.

Machinery, Soap
Gedge-Gray Co., The

Machinery, Special
Allbright-Nell Co., The
Brecht Company, The
Buffalo Fdy. & Machine Co.
Phoenix Iron Works Co.
Ruggles-Coles Eng. Co.
Stevens-Aylesworth Co.
Stokes, F. J. Machine Co.

Machinery, Thickening and Dewatering
Dorr Co., The

Machinery Transmission
Caldwell H. W., & Son Co.
Jeffrey Mfg. Co.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co., The

Machinery, Weighing
Schaffer Eng. & Equipment Co.
Sturtevant Mill Co.

Magnesite
Foote Mineral Co.
Harbison-Walker Refractories Co.

Magnetic Clutches
Cutler-Hammer Mfg. Co.

Magnetic Disc Brakes (Direct Current)
Cutler-Hammer Mfg. Co.

Magnesium Metal
American Magnesium Corp.
Leavitt, C. W., & Co.
Norton Laboratories
Shawinigan Electro-Metals Co.

Magnesium Ribbon
Daigger, A., & Co.

Magnetic Pulleys
Dings Magnetic Separator Co.
Magnetic Mfg. Co.

Magnets
Dings Magnetic Separator Co.

Magnets, Lifting
Cutler-Hammer Mfg. Co.

Manganese Ore
Lavino, E. J., & Co.

Metal, Asbestos Protected
Aspromet Company

Metallographic Apparatus
Holz, Herman A.
Scientific Materials Co.

Metallo-Radiographic Apparatus
Holz, Herman A.

Metallurgical Clay Goods
Denver Fire Clay Co.

Metallurgical Engineers
See Professional Directory, Pages 122, 123

Metallurgical Processes
Door Co., The
Dwight & Lloyd Sintering Co.

Metals
Bario Metal Corp., The
Electric Smelting & Alum. Co.
Ferro Alloy Co., The
Lavino, E. J. & Co.
Leavitt, C. W. & Co.
Metals Disintegrating Co.
Metal & Thermit Corp.

Meter Box Covers
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Meters, Flow, Air, Gas, Water
Spray Engineering Co.

WHAT AND WHERE TO BUY

Microscopes
Bausch & Lomb Opt. Co.
Central Scientific Co.
Scientific Materials Co.
Thomas Co., Arthur H.

Mills, Ball, Pebble and Tube
Abbé, Eng'g Co.
Abbé, Paul O.
Allis-Chalmers Mfg. Co.
Chalmers & Williams
Colorado Iron Works Co.
Hardinge Conical Mill Co.
Mead & Company
Mine & Smelter Supply Co., The
Patterson Fdy. & Mach. Co.
Stokes, F. J., Machine Co.

Mills, Conical
Hardinge Conical Mill Co.

Mills, Emery
Sturtevant Mill Co.

Mills, Hammer
Abbé, Paul O.

Minerals and Ores
American Magnesium Corp.
Carolina, Clinchfield & Ohio Ry.
Continuous Reaction Co., The
Lavino, E. J., & Co.
Leavitt, C. W., & Co.
Products Sales Co.
Shawinigan Electro-Metals Co.
Vanadium Alloys Steel Co.

Mixers, Acidulating
Pratt Eng. & Mach. Co.

Mixers, Batch
Abbé, Paul O.
Gedge-Gray Co., The
Pratt Eng. & Mach. Co.
Smith Engineering Works
Werner & Pfleiderer Co., Inc.

Monel Metal
Supplee-Biddle Hdwe. Co.

Montejus
See Acid Eggs, Cast Iron, also Stoneware

Motors, Electric
Lincoln Electric Co., The

Motor Speed Regulators
Cutler-Hammer Mfg. Co.

Motor Starters
Cutler-Hammer Mfg. Co.

Mufflies
Mine & Smelter Supply So., The
Russell Engineering Company

Nickel, Sheet
Driver-Harris Company

Nitro Compounds
Newport Chemical Works, Inc.

Nozzles, Spray
American Blower Co.
Buffalo Forge Co.
Carrier Engineering Corporation
Duriron Castings Co.
Schutte & Koerting Co.
Spray Engineering Co.
Star Brass Works, The

Nozzles & Jets, Stoneware
See Stoneware, Chemical

Oils, Flotation
See Flotation Oil

Oil & Grease Extraction Equipment
Bartlett & Snow, The C. O., Co.

Ore Bedding and Reclaiming Systems
Robbins Conveying Belt Co.

Ores
See Minerals and Ores

Ovens, Core
Foundry Equipment Co., The

Ovens, Laboratory
Central Scientific Co.

Oxide, Gas Purifying
Lavino, E. J., & Co.

Oxygen or Hydrogen Generating Equipment
Electrolytic Oxy-Hydrogen Lab., Inc.
International Oxygen Co.

Packing
Goodrich, The B. F. Rubber Co.

Paint, Pigment, Graphite
Acheson Graphite Co.

Paint, Acid Proof and Technical
Toch Bros.

Paint, Raw Materials for
Carolina, Clinchfield & Ohio Ry.

Pans, Vacuum
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Ltd.
Buffalo Fdy. & Mach. Co.
Detroit Heating & Lighting Co.
Devine, J. P., Co.
Kestner Evaporator Co.
Koven, L. O., & Bro.
Lummus, The W. E., Co.
Pfaudler Company, The
Pratt Eng. & Machine Co.
Scott, Ernest, & Co.
Sowers Manufacturing Co.
Stokes, F. J., Machine Co.
Swenson Evaporator Co.
Zaremba Co.

Patent Attorneys
See Professional Directory, Pages 122, 123

Pebble Mills
See Mills, Ball, Pebble and Tube

Perforated Metal
Mundt, Chas., & Sons

Photomicrographic Apparatus
Bausch & Lomb Opt. Co.

Pine Products
Pensacola Tar & Turpentine Co.

Pipe, Cast Iron
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau
Clow, James B., & Sons
Donaldson Iron Co.
Glamorgan Pipe & Foundry Co.
Lynchburg Foundry Co.
Massillon Iron & Steel Co.
U. S. Cast Iron Pipe & Fdy. Co.
Warren Foundry & Machine Co.

Pipe, Silica Ware
Thermal Syndicate, Ltd., The

Pipe, Silver
Wall Co., A. T.

Pipe and Boiler Covering
Magnesia Association of America

Pipe & Fittings, Cast Iron, Acid Proof
Acid Proof Iron Products Co.
Duriron Castings Co.
Pacific Foundry Co.
Simmons, John, Company

Pipe & Fittings, Copper
Badger, E. B., & Sons Co.
Lummus, Walter E., Co., The
Ott, George F., Co.

Pipe & Fittings, Enameled, Acid Proof
Elyria Enameled Products Co.
Pfaudler Co., The
Stuart & Peterson Co.

Pipe & Fittings, Lead, Tin or Silver Lined
Badger, E. B. & Sons Co.
Cleveland Brass Mfg. Co.
Lead Lined Iron Pipe Co.
Schutte & Koerting Co.
United Lined Tube & Valve Co.

Pipe & Fittings, Stoneware, Acid Proof
General Ceramics Co.
Graham, C., Chem. Pottery Wks.
Knight, Maurice A.
U. S. Stoneware Co.

Pipe & Fittings, Wood
National Tank & Pipe Co.
Pacific Tank & Pipe Co.

Pitch, Coal Tar
Barrett Co., The

Plant Sites
Carolina, Clinchfield & Ohio Ry.

Platinum Wire, Sheet and Foil; Crucibles, Dishes, Electrodes Laboratory Ware, all kinds
American Platinum Works
Baker & Co., Inc.
Bishop, J. & Co., Platinum Wks.
Thomas Co., Arthur H.

Plug Cocks
See Valves and Cocks

Pneumatic Tools
Ingersoll-Rand Company

Pneumercator
Pneumercator Co.

Porcelain Ware
Bausch & Lomb Opt. Co.
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Central Scientific Co.
Guernsey Earthenware Co.
Herold China & Pottery Co.
Mine & Smelter Supply So., The
Ohio Pottery Co.

Portable Conveyors
Barber-Greene Company
Portable Machinery Co.

Pots, Cast Iron, Acid Proof
Acid Proof Iron Products Co.
Bethlehem Foundry & Mach. Co.
Buffalo Foundry & Machine Co.
Duriron Castings Co.
Pratt Eng. & Mach. Co.
U. S. Cast Iron Pipe & Fdy. Co.

Pots, Stoneware, Acid Proof
See Stoneware, Chemical

Powdered Coal Equipment
American Industrial Eng. Co.
Locomotive Pulverized Fuel Co.
Powdered Coal Eng. & Equpt. Co.
Raymond Bros. Impact Pul. Co.

Powder, Steam & Electric
Carolina, Clinchfield & Ohio Ry.

Precipitants
Merrill Metallurgical Co.

Precipitators, Centrifugal
Schaum & Uhlinger, Inc.

Presses, Hydraulic
Hydraulic Press Mfg. Co., The
Perrin, Wm. R., & Co.

Producers, Gas
Steere Eng. Co.

Pulleys, Magnetic
Dings Magnetic Separator Co.

Pulverizers, Hammer Mill
American Pulverizer Co.
Bartlett & Snow, The C. O., Co.
K-B Pulverizer Co.

Pulverizers, Laboratory
See Machinery, Crushing, Grinding and Pulverizing, Laboratory

Pulverizing Machinery
See Machinery, Crushing, Grinding and Pulverizing

Pump Controllers
Cutler-Hammer Mfg. Co.

Pumps, Acid or Acid Gases
Abbé Eng'g Co.
Duriron Castings Co.
Elmore, G. H.
Monarch Mfg. Works
Nash Engineering Co.
Schutte & Koerting Co.
Taber Pump Co.
Worthington Pump & Mchy. Corp.

Pumps, Centrifugal
Abbé, Eng'g Co.
Chemical Pump & Valve Co., The
Duriron Casting Co.
Elmore, G. H.
Ingersoll-Rand Company
Monarch Mfg. Works
Taber Pump Co.
Worthington Pump & Mchy. Corp.

Pumps, Gas, Liquid or Vacuum
Monarch Mfg. Works

Pumps, Sand
Krogh Pump Mfg. Co.

Pumps, Stoneware, Acid Proof
General Ceramics Co.
Knight, M. A.
U. S. Stoneware Co.

Pyrites
Lavino, E. J., & Co.

Pyrometers
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Brown Instrument Co.
Bristol Co., The
Central Scientific Co.
Engelhard, Chas.
Holz, Herman A.
Hoskins Mfg. Co.
Palo Company
Pyrolectric Instrument Co.
Sargent, E. T., & Co.
Scientific Materials Co.
Shore Instrument Co.
Stupakoff Laboratories
Taylor Instrument Companies
Thomas Co., Arthur H.
Thwing Instrument Co.
Uehling Instrument Co.

Pyrometer Installations
Holz, Herman A.
Stupakoff Lamoratories

Pyrometer Protection Tubes
Engelhard, Chas.
Herold China & Pottery Co.
Stupakoff Laboratories
Thermal Syndicate, Ltd., The

Pyrometer Sheets, Graphite
Acheson Graphite Co.

Pyroscope
Shore Instrument Co.

Quartz Glass
See also Fused Silica
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Economy Eng. Co.

Railings, Iron
Anchor Post Iron Works

Railways, Industrial & Portable
Easton Car & Construction Co.

Re-Agent Cabinets
Schwartz Sectional System

Recorders, CO2
Uehling Instrument Co.

Recording Instruments, Pressure, Temperature, Electricity, Motion, Speed, Time
Bristol Co., The
Brown Instrument Co.
Holz, Herman A.
Engelhard, Chas.
Hoskins Mfg. Co.
Precision Therm. & Inst. Co.
Pyrolectric Instrument Co.
Taylor Instrument Companies
Thwing Instrument Co.
Uehling Instrument Co.

Refractories
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Refrigerating Machinery
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Regulators, Automatic Humidity
American Blower Co.
Carrier Engineering Corp.

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Regulators, Pressure and Temperature
Brown Instrument Co., The
Connersville Blower Co.
Powers Regulator Co.
Sarco Company, Inc.
Steere Eng. Co.
Taylor Instrument Companies

Resistant Chemical Glassware
International Glass Co., The

Respirators
Abbé, Paul O.
American La France Fire Engine Co.

Retorts
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Retorts, Graphite
Bartley, Jonathan, Cruc. Co.

Retorts, Vertical
Isbell-Porter Co.

Rheostats
Central Scientific Co.

Rolls, Crushing
American Pulverizer Co.
Buchanan, C. G., Co., Inc.
Jeffrey Mfg. Co.

Roofs, Walls, Partitions, etc., Concrete
Aspromet Company

Roofings and Sidings—Fume Proof
Aspromet Company
Brown Hoisting Machinery Co.

Safety Devices
American La France Fire Engine Co.

Safety Goggles
American La France Fire Engine Co.

Sample Cabinets
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Brooklyn Paper Mills
Burns & Roberts
Consolidated Products Co.
Genesee Chemical Co.
Goldsmith Bros., S. & R. Co.
McCoy Brandt Machy. Co.
Machinery Utilities Co.
Moores Lime Co.
Morse Bros. Mach. & Supply Co.
Payne, Howard B.
Perry, Buxton, Doane Co.
Stewart, Paul & Co.
Youngstown Welding Co.
Zelnicker, Walter A., Supply Co.

Scales, Conveyor
American Kron Scale Co.
Schaffer Eng. & Equip. Co.

Scales, Weighing
American Kron Scale Co.
Simmons, John, Company
Sturtevant Mill Co.

Scleroscope
Holz, Herman A.
Shore Instrument Co.

Screens
Abbé, Paul O.
Bartlett & Snow, The C. O., Co.
Caldwell, H. W., & Son Co.
Colorado Iron Works Co.
Kent Mill Co.
Multi-Metal Separating Screen Co.
Mundt, Chas., & Co.
Newark Wire Cloth Co.
Patterson Fdy. & Mach. Co.
Smith Engineering Works
Sturtevant Mill Co.
Worthington Pump & Mchy. Corp.

Screens, Chain
Codd, E. J., Co.

Screens, Wire, Brass, Copper, Steel, etc.
Tyler, The W. S., Co.

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Pratt Eng. & Machine Co.
Raymond Bros. Imp. Pulv. Co.
Williams Patent Crusher & Pulverizer Co.

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Sharples Specialty Co.
Tolhurst Mach. Works.

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Huff Electrostatic Separator Co.

Separators, Inclined Vibrating Screen
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Separators, Magnetic
Buchanan, C. G., Co.
Cutler-Hammer Mfg. Co.
Dings-Magnetic Separator Co.
Magnetic Mfg. Co.
Paxon, J. W., Co.

Separators, Steam and Oil
Braemer Air Conditioning Corp.

Sieves, Laboratory
Newark Wire Cloth Co.

Silent Chain
Link-Belt Company

Silos, Wood
National Tank & Pipe Co.
Pacific Tank & Pipe Co.

Silver Rod, Sheet and Solder
Wall, A. T., Co.

Sintering Processes
Dwight & Lloyd Sintering Co.

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Westinghouse Elec. & Mfg. Co.

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Link-Belt Company

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Standard Alloys Co.

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Acheson Graphite Co.
Acid Proof Iron Products Co.
Duriron Castings Co.

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Hagan, Geo. J., Co.
Laclede-Christy Clay Products Co.

Stoneware, Chemical, consisting of *Bottles, Carboy Stoppers, Coils and Worms, Crystallizing Dishes, Chlorine Generators, Decanting Pots, Dippers, Dipping Dishes, Faucets, Funnels, Kettles, Mortars and Pestles, Nozzles and Jets, Pots and Jars, Pitchers, Retorts, Receivers or Woulff Bottles, Sinks, Storage Jars, etc.*
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Graham, C., Chem. Pot'ry Wks.
Knight, Maurice A.
Monarch Mfg. Works
U. S. Stoneware Co.

Stopper Heads
Bartley, Jonathan, Crucible Co.

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Ansul Chemical Co.

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Chemical Const. Co.
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Switchboards
Westinghouse Electric & Mfg. Co.

Syphons, Acid, Stoneware
Knight, Maurice A.
U. S. Stoneware Co.

Syphons, Metal
Monarch Mfg. Works
Schutte & Koerting Co.

Tachometers
Brown Instrument Co., The
Foxboro Co.

Tanks, Cast Iron
Detroit Range Boiler Co.
Stevens-Aylsworth Co.

Tanks, Copper
Badger, E. B., & Sons Co.
Detroit Heating & Lighting Co.
Lummus, The W. E., Co.
Ott, George F., Co.

Tanks, Cyanide
Acme Tank Co.
Baltimore Co., The
Pacific Tank & Pipe Co.

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Elyria Enameled Products Co.
Pfaudler Co., The
Stuart & Peterson Co.

Tanks, Heating Regulators
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Tanks, Lead Lined, Acid Proof
Acme Tank Co.
Blair, Campbell & McLean, Ltd.
Eagle Tank Co.
Hauser-Stander Tank Co.
Johnson & Carlson
United Lined Tube & Valve Co.
Wendnagel Co.

Tanks, Steel
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Codd, E. J., Company
Detroit Range Boiler Co.
Hamburg Boiler Works
Kellogg, The M. W., Co.
Koven, L. O., & Bro.
Manitowoc Engineering Works
Phoenix Iron Works Co.
Stevens-Alysworth Co.
Stevens Brothers

Tanks, Stoneware, Acid Proof
General Ceramics Co.
Graham, C., Chem. Pot'y Works
Knight, Maurice A.
U. S. Stoneware Co.

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Baltimore Co., The
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Eagle Tank Co.
Hauser-Stander Tank Co., The
Johnson & Carlson
Kalamazoo Tank & Silo Co.
National Tank & Pipe Co.
Pacific Tank & Pipe Co.
Schwartzwalder, J., & Sons
U. S. Wind Engine & Pump Co.
Wendnagel Co.

Temperature Regulators
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Testing Sieves and Testing Sieve Shakers
Multi-Metal Separating Screen Co.
Tyler, The W. S., Co.

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Thermocouples, Platinum
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Pyroletric Instrument Co.

Thermometers
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Bausch & Lomb Opt. Co.
Brown Instrument Co., The
Central Scientific Co.
Engelhard, Chas.
Foxboro Co.
Gaertner, Wm., & Co.
Griebel Instrument Co.
Lenz Apparatus Co.
Precision Thermometer & Inst. Co.
Pyroletric Instrument Co.
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Thickeners (or Dewaterers)
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N. Y. Revolving Portable Elevator Co.
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Titanium
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Titanium Ores
Titanium Alloy Mfg. Co.

Tool Steel
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Tower Packing, Acid Proof, Stoneware
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U. S. Stoneware Co.

Towers, Acid
Acid Proof Iron Products Co.
Duriron Castings Co.

Towers, Acids, Stoneware
General Ceramics Co.
Graham, C., Chem. Pot'y Wks.
Knight, Maurice A.
U. S. Stoneware Co.

Tracks, Industrial and Portable
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Transformers
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American Transformer Co.
Kuhlman Electric Co., The

Transformers, Special & Precipitation Process
American Transformer Co.
Kuhlman Electric Co., The
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Transmission Belts
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Tungsten Ores
Continuous Reaction Co., The
Vanadium-Alloys Steel Co.

Turbo Blowers
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Turntables, Industrial Railway
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Ultra Violet Ray Lamps
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Duriron Castings Co.
Lead Lined Iron Pipe Co.
Pacific Foundry Co.
Pratt Eng. & Machine Co.
United Lined Tube & Valve Co.

Valves and Cocks, Stoneware, Acid Proof
General Ceramics Co.
Graham, C., Chem. Pot'y Wks.
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Simmons, John, Company
U. S. Stoneware Co.

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Sarco Company, Inc.

Vanadium Alloys
Standard Alloys Co.

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Hauser-Stander Tank Co.
Johnson & Carlson
Pacific Tank & Pipe Co.
Schwartzwalder, J., & Sons, Inc.
U. S. Wind Engine & Pump Co.
Wendnagel Co.

Ventilator or Car Cloth
Ludlow-Saylor Wire Co., The

Viscosimeter
Bausch & Lomb Opticial Co.

Wagon Loaders
Jeffrey Mfg. Co.
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Waterproofing Compound (Liquid)
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Water Still
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Newark Wire Cloth Co.
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Merrill Metallurgical Co.
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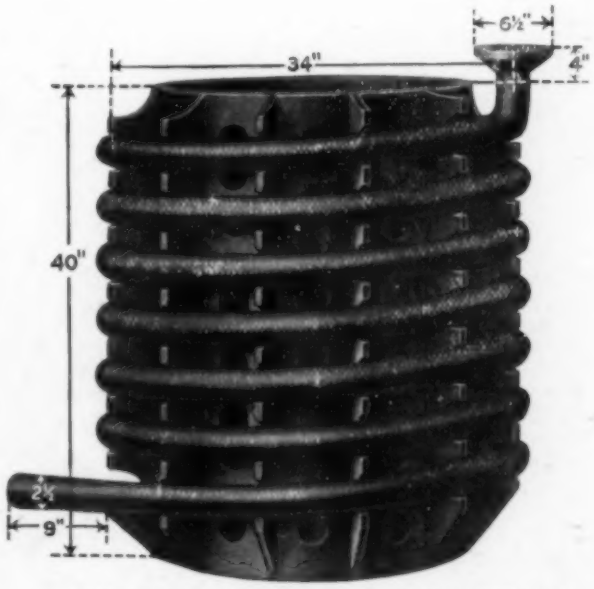
Acid-Proof Chemical Stoneware

OUR WARE IS NOT DEPENDENT UPON A GLAZE, ENAMEL OR VENEER

IT IS THE BODY ITSELF

Withstands the action of Acids, Alkalis and Chemicals, strong or weak, hot or cold



STANDARD No. 3—2½ in. BORE VALENTINER COIL
We make coils or worms in any length or bore pipe

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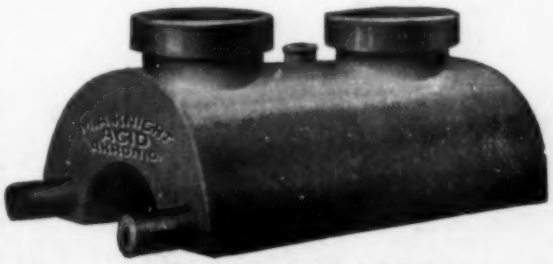
Made in any bore and most any center. We also make all kinds of flanged pipe in any bore or length, with fittings.



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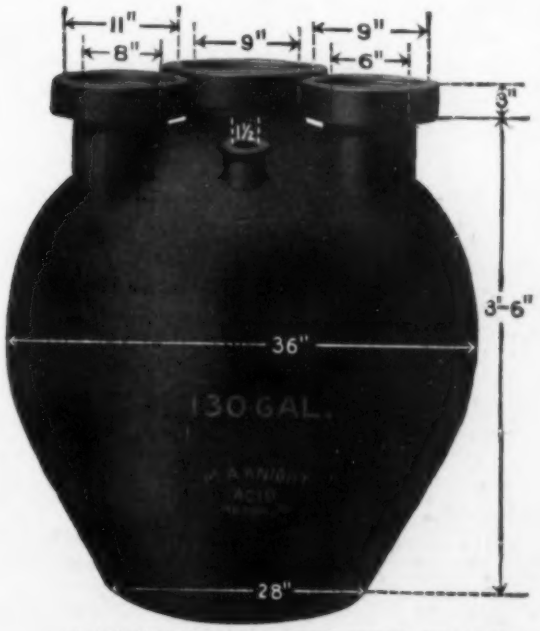

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